UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF MICHIGAN
SOUTHERN DIVISION

In re: FLINT WATER CASES	Civil Action No. 5:16-cv-10444-JEL-MKM (consolidated) Hon. Judith E. Levy Mag. Mona K. Majzoub
Elnora Carthan, et al., Plaintiffs, vs. Governor Rick Snyder, et al., Defendants.	Civil Action No. 5:16-cv-10444-JEL-MKM

HIGHLY CONFIDENTIAL
REMOTE VIDEOTAPED DEPOSITION OF
JOSEPH GRAZIANO, Ph.D.
VOLUME I

Thursday, October 29, 2020
at 9:01 a.m.

Taken at: Residence of Joseph Graziano, Ph.D.
Mount Kisco, New York

REPORTED BY: SARA S. CLARK, RMR/CRR
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(via Zoom)
- - -

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I N D E X

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P R O C E E D I N G S

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VIDEOGRAPHER: We are now on the record.

My name is Robert Martignetti. I'm a videographer for Golkow Litigation Services.

Today's date is October 29th, 2020, and the time is 9:01 a.m.

This remote video deposition is being held In Re: Flint Water Cases. The deponent is Joseph Graziano, Ph.D.

All parties to this deposition are appearing remotely and have agreed to the witness being sworn in remotely. Due to the nature of remote reporting, please pause briefly before speaking to ensure all parties are heard completely.

Counsel will be noted on the stenographic record.

The court reporter is Sara Clark, and will now swear in the witness.

- - -

JOSEPH GRAZIANO, PH.D.

being by me first duly sworn, as hereinafter certified, testifies and says as follows:

EXAMINATION

BY MR. TER MOLEN:

Q. Good morning, Dr. Graziano. How are you?

A. Very good. Thank you, Mark.

Q. Good. Good. Good.

I represent VNA in this litigation. I'll be taking the lead in asking you questions today.

The deposition has, I believe, been set for two consecutive days. My guess is I'll take most of today and we'll see about my going into tomorrow, and then other counsel representing other parties will be asking you additional questions as well, I'm sure.

Why don't we get going. And just at the outset, Doctor, you've been deposed as an expert witness before, right?

A. That's right.

Q. Okay. Anytime in the last four years?

A. Once.

Q. Okay. I'm going to presume, then, on your part some familiarity with the basic rules here. The key point I would suggest -- or ask you to follow, Doctor, is if you don't hear a question that I ask you or you don't understand it, let me know and I'll repeat it or rephrase it.

Okay?

A. Fine.

Q. And you're doing a good job so far, but in addition, to make life easier for all of us, and in particular, for Sara, the court reporter, if you can just wait a minute to make sure I finish my question before you start answering, that will be very helpful.

Okay?

A. Will do.

Q. All right. You understand you've been retained as an expert witness in this litigation, correct?

A. That is correct.

Q. Who is it who retained you?

A. Napoli Shkolnik.

Q. When did they first contact you?

A. So it's -- I think I have to tell a little story here.

I was working on -- the only case in the last four years where I've been deposed was a case in Colorado, a law firm, Burg Simpson, a case of occupational lead poisoning. And when that wrapped up, I became retained by them in a second case unrelated to that first, in which Napoli Shkolnik was co-counsel.

And as a result of that, Paul Napoli actually visited me in my office at Columbia and a discussion of the Flint case came about. I can't put the exact timeline on that, but I recall that I started to work on this sometime in April of -- I guess it was 2019 or '20.

THE WITNESS: Patrick?

Q. Well, was it this year, sir, do you recall, or last year?

A. Well, my interaction with Paul Napoli was last year, but the involvement in this case was 2020.

Q. Okay. Have you worked on other cases with the Napoli law firm?

A. I'm currently involved in another case

that is in its early phases.

Q. Is this the case you mentioned in Colorado?

A. Yes. It's an extension of that, yes.

Q. This is a mining case?

A. No, it is not.

Q. Is it also a lead case?

A. No, it is not.

Q. I would gather it's an arsenic case, then.

A. No, it is not.

Q. What substance is involved in that case, Doctor?

A. PFOA and PFOS.

Q. Interesting.

MR. TER MOLEN: We'll introduce what we'll mark as Exhibit 1, which is a copy of the one invoice we've received from the Napoli firm that relates to this case, Doctor.

- - -

(Graziano Exhibit 1 marked.)

- - -

BY MR. TER MOLEN:

Q. And Doctor, just as an aside here, for

purposes of Zoom, this process, what we'll do is we'll show you the document on the screen.

Can you see that, sir?

A. Yes, I can.

Q. Terrific. If you need it larger, smaller, let us know and we'll zoom in and out as appropriate.

And what we'll plan to do, Doctor, when we first show you a document is just to quickly scan through it so you can see the full document, and then I'll ask you to confirm that the document appears to be what I have represented it is.

Okay?

A. Okay.

Q. All right. So showing you what we'll mark as Exhibit 1, this is a copy of an invoice that you submitted in this case, right?

A. That is correct.

Q. Okay. And this is dated May 25th, right?

A. Right.

Q. Have you submitted any other invoices?

A. No, I have not.

Q. And this invoice reflects --

MR. TER MOLEN: If you can scroll down, please, Sam.

Q. -- the total amount of time that you have spent in this case through approximately end of May was 46 hours, right?

A. Right.

Q. Since May, you prepared your expert report in this case, right?

A. Well, this was in conjunction with the submission of my report.

Q. Okay. Have you done additional work since May?

A. No, I have not.

Q. Okay. So the 46 hours represents the vast majority, and perhaps all, of your work to date on this case; is that right?

A. That's correct.

MR. TER MOLEN: And then, Sam, if you could please scroll up.

Q. Here, at the outset, this is -- Exhibit 1 is summarizing materials that you have reviewed, right?

A. These are materials that were -- 1 through 6 were provided to me by

Patrick Lanciotti.

Q. Okay. And then you've omitted Number 7 here that says "various other documents."

What's included under Number 7?

A. What's included under Number 7 are the references that I used to write my report. And they are at the back of my report.

Q. Okay. Terrific.

So by "references," you mean various scientific studies; is that fair?

A. That's correct.

Q. Okay. And you indicated that 1 through 6 were sent to you by counsel, right?

A. That is right.

Q. Okay. Had you asked counsel to send you those specific documents, or those are documents that counsel selected for you and sent to you?

MR. LANCIOTTI: Objection; privileged.

Dr. Graziano, if you can answer that question without going into specifics about our conversations, please do so.

A. Well, I was already quite familiar with, Number 1, the publication by Hanna-Attisha, which they sent to me. And I don't recall -- I think it

was their decision to send me the other items.

Q. Okay. Terrific.

And you've not asked to see the depositions -- depositions of individuals other than those that were sent -- that are identified here as Number 6; is that right?

A. That's right.

MR. LANCIOTTI: Objection; form.

Q. Is that correct, Doctor?

A. That is correct.

Q. Okay. And why did you -- do you know why you were sent those four, I think it is, depositions?

A. I do not know why I was sent those four.

Q. Okay. Are the four depositions identified here depositions of different plaintiffs or plaintiff guardians, if you know?

A. As I recall, they were guardians. Parents, guardians.

Q. Okay. Terrific.

And you have a written retention agreement with plaintiffs for this case; is that right?

A. I do.

Q. We'll show you what we've marked as Exhibit 2.

- - -

(Graziano Exhibit 2 marked.)

- - -

BY MR. TER MOLEN:

Q. Okay. You agree, Doctor, that Exhibit 2 appears to be a copy of your retention agreement in this case?

A. Yes, I do.

Q. Okay. And it's -- from your perspective, is this a standard form retention agreement that you would enter into for all of your expert witness work?

A. I gather so. I don't do much expert witness work.

Q. What did you do to -- let me start over.

What did you do to prepare for the deposition today, Doctor?

A. I reread my report more than once; I spent a couple of hours yesterday rereading a couple of the references, specifically the Hanna -- Mona Attisha paper. And that's about all. Tried to relax, frankly.

MR. TER MOLEN: Okay. Let's put up a copy of your report that we'll mark as Exhibit 3, your report in this case.

- - -

(Graziano Exhibit 3 marked.)

- - -

MR. TER MOLEN: Great. Thanks, Sam.

BY MR. TER MOLEN:

Q. Doctor, you agree that Exhibit 3 appears to be a copy of the report that you prepared for this case?

A. Yes, I do.

Q. Did you have any assistance in preparing this report, Doctor?

A. No, I did not.

Q. Did you provide any drafts of this report to counsel?

A. No, not that I recall at all.

Q. Did you provide drafts of this report to anybody else?

A. No, I did not.

Q. Are you aware that plaintiffs' counsel has retained other experts for this case?

A. Yes. I don't know who they are, but

yes.

Q. Okay.

A. I'm sure I'm not the only one.

Q. Okay. You may have just answered this question, Doctor, but to be clear, have you had any communication with any other experts retained by plaintiffs' counsel in this case?

A. No, I have not.

Q. Have you been provided with reports prepared by experts retained by plaintiffs' counsel in this case?

A. No, I have not.

Q. Other than plaintiffs' counsel in this case, have you had communication with anybody else regarding this case?

A. No, I have not.

Q. In addition to the cases in which you've been retained, Doctor, there are additional cases that the lawyers involved in the litigation refer to as the class case or class cases.

Are you familiar with those cases?

A. No.

MR. STERN: Object to form. They are proposed class actions. They have not yet been

certified.

Q. For purposes, Doctor, of preparing your report, other than the depositions that were identified, I think, as Item 6 in your invoice, Exhibit 1, have you received any material whatsoever related to the plaintiffs in this litigation?

A. No. What I gave you on that list is what I was provided.

Q. Okay.

A. I think I was also provided at one point with a timeline.

Q. I see.

Who prepared that timeline?

A. I -- Napoli Shkolnik. I don't know -- that's where it came from, but...

Q. Okay. Is that timeline part of your file in this case, Doctor?

A. No. I glanced at it, and I had read -- I had read already a couple of papers about the timeline. A couple of them are referred to -- I can't remember the authors' names -- in my report. And it was, to me, old news by then, so I really didn't pay much attention to it.

Q. Okay. And you're not a medical doctor, correct?

A. Correct.

Q. Fair to say you have not examined any of the plaintiffs in this case, Doctor?

A. No, I have not.

Q. You have not received any medical records for plaintiffs in this litigation, correct?

A. Correct.

Q. Let's show you what we'll mark as Exhibit 4, which is a notice of the deposition of you today in this case, Doctor.

- - -

(Graziano Exhibit 4 marked.)

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BY MR. TER MOLEN:

Q. Have you seen Exhibit 4, the notice for your deposition, before today, Doctor?

A. Yes, I have.

Q. Okay. And I presume that you collected the materials in your file and provided them to Mr. Lanciotti?

MR. LANCIOTTI: Objection; form.

A. So the materials in my file consist of my report, and I provided the key references that I used in writing that report, which were an ATSDR profile, toxicologic profile on lead; an EPA document, Integrated Science Review of Lead; and I provided a copy of the retention agreement; perhaps one or two other things. I don't exactly recall.

Q. And in addition, obviously, the deposition transcripts that you identified in your invoice, right?

A. The deposition transcripts, I could not access to provide them. They were provided with a secure link that I went back and tried to access, and it wouldn't let me in. So I couldn't revisit those documents, actually.

Q. Okay. Understand.

Doctor, let's talk a bit about your prior testimony in other cases. Okay?

A. Sure.

Q. You identify in your report one case in which you've been deposed in the last four years, right?

A. Right.

Q. That's the Buckler versus Johnson Control case?

A. That is correct.

Q. What was that case about?

A. Mr. Buckler worked for decades for -- in a battery-producing factory owned and run by Johnson Controls. And he had suffered the consequences of occupational lead poisoning. Many, many adverse health effects. And I was retained to essentially talk about relationships between lead toxicity and his set of symptoms.

Q. How old, approximately, was Mr. Johnson -- I'm sorry -- Mr. Buckler when you got involved in the case?

A. I believe he was in his early 60s.

Q. I'm sure you looked at blood lead levels for Mr. Buckler.

A. Yes, I did.

Q. And what were those levels, approximately?

MR. LANCIOTTI: Objection.

I'm not sure if Dr. Graziano can disclose confidential medical information of -- of Mr. Buckler here.

THE WITNESS: I agree. I'm not sure where this falls under HIPAA. But should I be revealing his records?

BY MR. TER MOLEN:

Q. Okay. We'll go about this in a different way, Doctor. I understand the concern.

Is it fair to say that -- well, you would characterize his exposure as occupational exposure, right?

A. That's correct.

MR. LANCIOTTI: Objection to form.

Q. Okay. And is it fair to say that his blood lead levels, Doctor, were above 15 micrograms per deciliter?

A. Yes.

MR. LANCIOTTI: Same objection.

MR. STERN: Object to form; foundation; violations of federal law by way of disclosure.

BY MR. TER MOLEN:

Q. Okay. I think you answered "yes" to that question. Is that correct, Doctor?

A. That's correct.

Q. Okay. Was that case resolved?

A. It settled before going to court.

Q. Okay. Did you examine the plaintiff in that case?

A. No, I did not.

Q. Did you receive any records regarding the plaintiff in that case?

A. Yes, as I recall, I did.

Q. Did you become aware of any other experts retained by plaintiffs in that case?

A. I recall -- I probably did, but I couldn't tell you who they were.

Q. Okay. And, Doctor, approximately how many other cases besides the Buckler versus Johnson case have you testified in?

A. In my -- I'm in my 49th year of my academic career, and I would say it's six or seven cases. I had many opportunities along the way to get involved. I was department chair and associate dean and was running many research operations and always to "Thank you, but no thank you." Three years ago -- I'm ramping toward retirement. In fact, in two months from now, I will become a professor emeritus and will step away as full-time faculty.

But in the last three years, '18, '19,

and '20, I moved to a half-time appointment. And so I found myself with some time to begin to get engaged as an expert.

Q. Thank you for that summary.

Can we -- I would like to work our way back in time, Doctor, about these other six or seven cases, if you can walk me through.

So let's start with the one that was most recent in time, understanding that you've already talked about the Buckler case.

A. Going back prior to that?

Q. Yes.

A. I recall one case where it -- I am a professor of pharmacology. I worked early in my career on drugs related to hematologic diseases. And, in fact, my original appointments as a young faculty member were in pediatric hematology/oncology, and I was a member of the American Society of Hematology.

The case was actually a prescription misfill that killed the plaintiff. He was a gentleman, former Navy officer who worked in submarines, and he had been exposed to radioactivity. And so he already had some

significant underlying disease -- hematologic disease related to his radiation exposure.

And the pharmacy misfilled his prescription with a drug that sounded like but wasn't the appropriate drug. And that drug was absolutely contraindicated for somebody who had his underlying condition. And he proceeded to, in short order, die.

And so I was called in as a pharmacologist with expertise in hematologic diseases.

And that case went to court, and plaintiff's family was awarded a considerable sum.

Q. Okay. And I take it you testified -- I think you said this, Doctor -- for the plaintiff in that case?

A. I did.

Q. And "hematological" means blood related; fair to say?

A. Sorry? Say again?

Q. "Hematological," a layman way of saying that, would be blood related?

A. Yes. Blood diseases.

Q. Okay. Very good.

Approximately when was that case, Doctor?

A. It's probably 10 or more years ago.

Q. All right. What was the next most recent case that you can recall?

A. If we go back in time, I did a series of cases -- let's see, my kids -- my son was in college, so this goes -- my son was born in '69. It goes back to the -- to, like, the late '80s or early '90s. I worked with a law firm, Landman Corsi Ballaine & Ford in New York City, and there were several cases of childhood lead poisoning over the course of two, three years. It was at a point in time when I had two children in college, and the extra income was helpful, frankly.

And in those cases, sometimes it was on behalf of the plaintiff and sometimes it was on behalf of the defendant. For example, I recall one case where the child spent time, of course, in his or her parents' home, but also spent time at a nursery school, at grandma's house. And the question there was whose lead was it that led this -- I don't remember if it was a little boy or girl -- but led this child to develop an elevated

blood lead.

And the attorneys that I was working for were defending either the nursery school or grandma's house, which it turned out to be not -- in my opinion, based on inspections of the facility and so forth, not the source of lead exposure.

So in that case, I was working with the law firm defending a landlord, if you will.

Q. Okay.

A. In other cases -- and I think there were four altogether. In some other cases, I was working on behalf of the plaintiff, the lead-poisoned child and family, actually assigning blame, if you will, to this -- to whatever apartment or building it was.

Q. Okay. And you had mentioned a particular plaintiff -- a particular law firm in New York City.

Was that the law firm with which you worked on behalf of the plaintiffs?

A. Yes.

Q. For the one case where you were representing a defendant, you mentioned that the

child in that case had developed an elevated blood lead level, right?

A. That's right.

Q. What was that blood lead level, approximately, if you can give me a range?

MR. LANCIOTTI: Objection; foundation.

A. I cannot.

MR. LANCIOTTI: And to the extent it violates federal laws.

A. This was in the 1990s. I do not recall.

Q. Okay.

A. Yes.

Q. But by using the term "elevated," fair to say more than 15 micrograms per deciliter?

MR. LANCIOTTI: Objection; foundation.

A. Yes.

Q. Okay. And the source of the blood lead level in that case where you represented a defendant, Doctor, was that from lead paint?

A. Yes, it was.

Q. And then the three or four cases where you were representing the plaintiffs, Doctor, you indicated you were identifying which structure was the source of the lead exposure; is that right?

MR. LANCIOTTI: Objection to form.

A. So part of -- part of my role was to look at inspections done by whatever department of health it was, inspections of the home, and to look at what they had uncovered. And part of it was actually simply to give an opinion about plausibility of the health effects that had been observed in the children. And that's -- yeah.

Q. Okay. That's helpful.

In the cases where you were working on behalf of the plaintiff that we're discussing here with respect to lead exposure, those were all lead paint cases, Doctor?

A. Yes, they were.

Q. Okay. And the blood lead levels in those cases, Doctor, were all greater than 15 micrograms per deciliter?

MR. LANCIOTTI: Objection; form and foundation.

A. Yes, they were.

Q. Are there other cases that you can recall, Doctor, in which you've testified as an expert?

A. No.

Q. And in the cases where you were representing the plaintiff regarding lead that we were discussing, Doctor, did you personally examine any of the plaintiffs?

A. No, I did not.

Q. Did you receive medical records regarding any of the plaintiffs?

A. Yes, I did.

Q. To your knowledge, Doctor, has a court ever excluded all or part of any of your opinions?

A. No, they have not. Never.

Q. Have you ever testified as an expert with regard to arsenic, Doctor?

A. No, I have not.

Q. Okay. And is it fair to describe your current focus as focusing on arsenic?

A. Yes. For the last 20 years or so. As you may know, I worked primarily in Bangladesh but also in the state of Maine, where naturally-occurring arsenic in drinking water -- in groundwater used for drinking purposes has led to health effects in adults and children.

That said, though, however, lead -- blood lead -- because we learned that arsenic,

like lead, has adverse effects on cognitive function, neuropsych performance, we would, to the extent possible, also measure lead in blood, which became a covariant, if you will, in unraveling the consequences of arsenic on cognition. So we had to control for, in many of my published works, for lead.

So I haven't abandoned lead by any stretch.

Q. I understand. And I appreciate that explanation.

You've been the head, if I understand correctly, of a particular group that's funded through the department in which you work called the Superfund program; is that right, Doctor?

A. So I lead -- I'm phasing out. I've passed the baton just recently, but I lead a team of roughly 15 scientists across Columbia University, in public health, in medicine, pediatrics, in the geosciences. And we were funded in April of 2000 to conduct what was originally a set of seven research projects. It was called "Health Effects and Geochemistry of Arsenic and Lead." Eventually it morphed into

"Health Effects and Geochemistry of Arsenic and Manganese," which occurs in the Bangladesh drinking water.

And so we were funded for 20 years. I was director of that large interdisciplinary initiative.

Q. Very good. Thank you.

And can you walk me through the positions you've held at Columbia, please.

A. Sure. I came to Columbia in April 1979. I had been, prior to that, at the Rockefeller University in Manhattan and at Cornell Medical School in Manhattan. Cornell, I was an assistant professor of pediatrics and of pharmacology.

And in '79, I was recruited to Columbia, where I again had appointments in pediatrics and pharmacology. I was recruited because, primarily, I was working on the development of a drug to treat childhood and occupational lead poisoning. And the physician who recruited me, Sergio Piomelli, we had collaborated before. He was the head of pediatric hematology-oncology at NYU, and he was being recruited to head

hematology-oncology. And he said, "Joe, I'd really like you to come with me. I need" -- you know, we had been doing terrific work collaboratively. And he had also a keen interest in lead poisoning. He's the one who discovered one of the mechanisms whereby lead causes anemia, inhibition of the synthesis of hem- -- of hemoglobin.

In any case, he recruited me in '79. And I had -- my laboratory was in the department of pediatrics although my academic appointment was really in pharmacology. I taught medical pharmacology for 38 years to first-year medical students.

And in 1985 or so, I actually moved my laboratory from the department of pediatrics into the pharmacology department, which was really at that point a better home for my work. I actually carried out a series of, first, laboratory studies and then clinical trials in collaboration with my partners in pediatrics, evaluating the safety and efficacy of a drug now known as succimer, which is now used around the world to treat childhood and occupational lead poisoning.

We first did a trial -- we didn't want to start in children. We started in men with occupational lead poisoning. And we recruited men from the Tri-state area. They ranged from house painters to bridge painters to policemen who worked at the firing range. And we established the safety and efficacy of this drug, succimer, in adults, and then moved on to conduct two trials of the drug, first one in children with moderately elevated blood leads, and then the second one in children with more severely elevated blood leads.

I worked on that drug for 14 years. And as I approach retirement and I reflect on my career, that's one of the things I'm most proud of. It was an orphan drug, so to speak. Drug companies weren't interested in developing a drug for a condition that was declining over time because we got rid of lead in paint and we got rid of lead in gasoline.

And so the drug was developed virtually entirely with money from NIH, National Institutes of Health, and it's a rare example of such a drug developed with government money.

But the drug was approved by the FDA in

1991.

I'll come back to my career, because my career had a shift in 1991.

But when the drug was approved, I went -- if I may, I walked into my laboratory, the people who had worked with me for 14 years, and I told them, "Sit down. I have news. Just learned that FDA approved the drug."

And I like telling this story to students. What do you think they did? They all started crying. It was such an emotional thing after 14 years. I often tell students, "Science is the ultimate in delayed gratification, you know, 14 years of work."

But I will come back to 1991.

But to jump ahead, just to finish this story with the drug, in 2013, I got a phone call from a Reuters reporter who had just been to Nigeria where there was an outbreak of fatal lead poisoning due to what they call "artisanal gold mining." There was a pit mine -- a large pit mine in Nigeria where the ore also contained lead. And poor people would go into the pit mine and steal the ore, basically, and bring it home and process

it. And in the process of doing that, the lead was disseminated into their villages.

And Doctors Without Borders actually discovered these villages that were off the grid, so to speak, when they were going around doing well-baby vaccinations.

To cut to the chase, Doctors Without Borders used my drug -- the drug to treat hundreds and hundreds of cases, and it led to a reduction in the mortality rate from 42 percent to 2 percent.

So they eventually, Doctors Without Borders, petitioned the World Health Organization to add the drug to the so-called list of essential medicines. So it became the 66th drug on the list of essential medicines. So if I were to go set up a clinic in a pharmacy in some obscure part of this planet, I would stock that pharmacy with the list of essential medicines so you have drugs to treat anything -- any condition that walks in the door. So I'm proud of that.

But back to 1991, in the mid-'80s -- I'm sorry. I have to go back one step further.

1978, while I was at Cornell Medical

School, I was asked to be a consultant to the World Bank, which was lending money to the renovation of a lead smelter in the former Yugoslavia in what is now the Republic of Kosovo. I was invited, in part, because of my work on lead. The lead drug was now getting some attention. And a bank cannot lend money to any project that would become an environmental health hazard to the community.

Q. Doctor, if I could just stop you for a minute to make sure I'm following the timeline here. I'm sorry. But you mentioned the drug was approved in 1991, right?

A. That's right.

Q. And I thought I heard you -- and I may well have been mistaken -- that you were retained as a consultant by World Bank in 1978?

A. That's right.

Q. Okay. And I'm just trying to reconcile the approval of the drug with the timing of your retention when you're linking that to the drug, if you don't mind explaining.

A. Not at all, no.

There was another faculty member at

Cornell, a man named Ernst Friedheim, who was very, very much senior to me. And quite frankly, he was the one who the bank came to engage and bring on as a consultant to the bank. He then asked me if I would join him. And so I was the caboose, if you will, on this duo who went to the former Yugoslavia. And we conducted -- and you'll see why I'm telling this story in one moment.

We conducted a survey with physicians in that mining town, a survey of blood lead concentrations in children who had been exposed to the legacy of the smelting operation. And, indeed, they had a very high rate of elevated blood lead concentrations. Very high lead concentrations, in the 40s and 50s.

And what I'm getting at is that collaboration with physicians in the former Yugoslavia led to my first engagement in the field of public health -- of environmental health. I came home and I gave a grand rounds in pediatrics to the pediatrics department at now -- it was by now '79 -- at Columbia. It was my new home. And it was -- "Diagnosis and Treatment of Lead Poisoning" was the title. Childhood lead

poisoning. And in the audience was a professor of epidemiology, Zena Stein. Very famous professor. I won't go into her history.

But when -- in the last 10 minutes of my grand rounds, I told this little story about, "Hey, I was just in Yugoslavia in this town where there's this rampant lead poisoning due to mining activities."

And at the end of it, she came over to me and she grabbed me by the lapel and she said in a very endearing way, "Now, you come with me, young man, because I work on mental disabilities in children." And the WHO had just declared lead exposure as being the number one preventable cause of mental disability in children.

So she formed a working group in 1983 that included myself, an epidemiologist, a pediatrician, a biostatistician, a research psychologist. And we met weekly for a year because she, and then I, wanted to develop a strategy for studying children in that mining town. Because at the time, it was not as well known as it is today, as I write in my report now. It was still up for grabs as to whether lead was

causally related to deficits in child intelligence, among other things. And it was that collaboration -- and so we wrote an NIH proposal. I was the principal investigator. She was the lead epidemiologist. And we got funded. And we began one of the seven large prospective studies at the time that followed children actually from before birth -- we recruited pregnant women, 2,000 pregnant women, and we followed them through the birth, and then we followed a subset of those births out through age 12.

Because of that work, which was really public health -- it was no longer pharmacology -- my career actually took a turn toward public health -- Zena, the epidemiologist, actually threw my name into the hat when the position of chairman of the department of environmental health sciences became open. She nominated me to become chair.

And so, indeed, in 1991, I was recruited by our late dean, Allan Rosenfield, to move across the street, if you will, from the medical school to the school of public health. And I assumed the role as chairman of the department, which I held for 12 years. I stepped down, and then I was

called back as interim chair at some point along the way.

So that's the trajectory of my career at Columbia. When I stepped down as chairman, the dean asked me to assume the role of associate dean for research. He said essentially, "I still want you at my table." And so I assumed that role, which I had for a period of seven years.

Q. Okay. Thank you, Doctor. That's a very interesting and thorough summary.

I'm going to go back in time a little bit here and just maybe restate some things in my own words to make sure I understand.

So pharmacology, that's -- fair to say that's the study of drugs?

A. Correct.

Q. And --

A. If I may add one more thing?

Q. Go ahead.

A. It's also the study of the adverse effects of drugs, not just the efficacy of drugs. In the old days, pharmacology departments were known as the department of pharmacology and toxicology.

Q. Okay. Fair point.

To study the drugs and their effects on people, whether they're positive or adverse, fair?

A. Right. People and animals. Yeah.

Q. And you mentioned you had developed with funding from NIH and help from, it sounds like, a variety of colleagues and students, a drug that you pronounced -- is it succisoma?

A. Succimer.

Q. Succimer.

Do you mind spelling that for us? I think Sara would appreciate that.

A. S-U-C-C-I-M-E-R.

Q. And you mentioned that it's a treatment for lead poisoning; is that right?

A. Yes. It's what's called a chelating agent.

Q. Okay.

A. C-H-E-L-A-T-I-N-G.

Q. And I was going to ask you about that. Chelating agents, in general, in layman's terms, they're designed to help rid the body of lead, right?

A. Uh-huh.

MR. LANCIOTTI: Objection; form.

A. Chelating agents are designed to rid the body of lead or other toxic metals.

Q. Understand.

A. My own work on chelating agents actually began when I was working on hematological diseases, diseases like sickle cell disease, Cooley's anemia, where a subset of those patients accumulate excess iron. My work originated -- work trying to develop drugs, chelating agents, for iron overload.

Q. I understand. Thank you.

And there are -- for children, there are risks with chelation, correct?

MR. LANCIOTTI: Objection; form and foundation.

A. All drugs are toxic. The first line in an opening class of medical students. So, sure, all drugs have risks.

Q. Well, for children, the chelation process means that their bodies are shedding a number of substances that they might need to develop.

Is that fair or not?

MR. LANCIOTTI: Objection; form and foundation.

A. Well, that's a good point. And the drugs that were available before succimer, a drug like EDTA, was not specific for lead. It removed lead, but it also removed zinc and copper and iron. So the problems with the earlier drugs is they were not specific and they led to the depletion of essential minerals.

One of the attractions of succimer is that it only removes heavy metals. It removes lead, it removes arsenic, it removes Mercury, but it doesn't touch the essential minerals.

Q. Okay. Very good. I can see why that would have been an improvement on what was available previously, Doctor.

A. And, if I may, succimer is an oral drug. It's a pill. EDTA was an injectable drug. So children would have to be hospitalized. The case -- for example, Doctors Without Borders in Nigeria, they couldn't hospitalize anyone to get EDTA. So having -- the benefit of having an oral medication was important.

Q. Appreciate that. Thank you.

And what blood lead level would be required, in your view, before administration of succimer would be appropriate?

A. The blood lead that's required -- and this is agreed upon by pediatricians across the country -- is a blood lead of 45 micrograms per deciliter.

Q. Okay. In describing some of your earlier work, you indicated that there were -- you distinguished between individuals who had moderately elevated blood lead levels and seriously elevated blood lead levels.

Do you recall that?

A. I do.

Q. Can you explain what you mean in whatever way is easiest for you, perhaps in terms of range, what you mean by moderately versus seriously?

A. Sure. I wish I had gone back and looked at the papers there from the mid-1970s. But moderately elevated, I believe we recruited children with blood leads between 30 and 50, or thereabouts, and the severe case, the subsequent clinical trial, was in children with blood lead

concentrations of 50 and above.

Q. Okay. Thank you.

And just to follow your trajectory at Columbia, Doctor, you remained as dean, then, of the school of public health through approximately 2003, 2004?

A. Not dean.

Q. I'm sorry. Go ahead.

A. Associate dean for research. One of many associate deans. And I retained that position until, frankly, after we got a new dean. I loved working for Allan Rosenfield. He was just -- he was the person who recruited me in the first place. He died, gosh, in -- about 15 years ago, something -- and then it was logical for the new dean to have her own people in place.

Q. Sure. Sure. Understand.

And I misspoke, Doctor. You were the chair of the department of public health from -- at Columbia from approximately 1991 through 2003 or 2004?

A. The name of the department was the department of environmental health sciences.

Q. Okay.

A. From 2000 until 2001, almost -- sorry -- yeah, 2001 or '2. I would have to look at my CV.

Q. Okay. Terrific.

And so you -- in approximately 1991, then, your title changed from being a professor of pharmacology to a professor of environmental health sciences; is that right?

A. Yes. But I retained my professorship in pharmacology and I continued to teach first-year medical students through all those years. I just stopped teaching first-year medical students, pharmacology, just -- when I went to half-time, just a few years ago.

Q. Okay. Thank you.

You are not an epidemiologist, correct?

A. That's correct, though I have, as I mentioned, collaborated with world-class epidemiologists since the early '80s. My late wife was an epidemiologist.

Q. There's host collaboration.

A. Yes.

Q. And when you collaborate with somebody, they bring their expertise and then you bring your expertise; fair to say?

A. Fair to say.

Q. And like your work that you've described as focusing on arsenic for the last 15, 20 years or so, you'd agree that your publications for the last 15 years or so have focused on arsenic?

A. Primarily on arsenic, but in the later publications, on mixtures of metals.

One of -- including lead.

One of the challenges, you know, we are all exposed to many, many environmental toxicants. And one of the challenges over the years -- and we all study things one element at a time, but all realizing that no child is exposed to just one substance.

And it was about seven or eight years ago that the director of the National Institute of Environmental Health Sciences, Linda Birnbaum, introduced as part of the strategic plan of her institute, NIEHS, which is one of the NIH institutes, the push to develop statistical methods to be able to study mixtures -- what we call mixtures. And those methods have evolved. In fact, there are faculty in my department who are at the forefront of developing new statistical

methods.

So in the past few years, my work studying arsenic in lead and manganese and cadmium in children in Bangladesh has actually involved new statistical methods -- not -- you know, I'm not the statistician, but involved new statisticians so that one can actually look at this, what is the impact of the four metals and which one is the bad actor, which one's next, and next.

Is that fair? So, again, I'm a metal toxicologist. It's not -- it's not as though I move from lead to arsenic and abandon everything I've done in the past.

Q. I understand.

You agree that your work over the last 15, 20 years -- I heard some background noise here. Let me start over again.

I understand that you agree that your work over the last 15 or 20 years is focused on arsenic, right?

A. Yes.

Q. And the different -- the mixtures you're talking about, I think what you're doing, at least

in part, Doctor, is introducing the concept of confounders?

MR. LANCIOTTI: Objection; form; foundation.

A. Yes. You could consider a mixture of metals to be introducing confounders, considering -- in a novel way, considering confounders.

Q. Right.

Meaning that different metals can have similar potential effects on humans, right?

MR. LANCIOTTI: Objection; form and foundation.

A. Right.

Q. Okay. Doctor, in your report, you note -- I can put this up if you want me to, but I suspect you'll recollect this, but you can tell me if I'm wrong -- in your report, you note that you've gone out of your way not to cite your own publication record.

And did you recall writing that?

A. I do.

Q. Okay. And why did you go out of your way not to cite your own papers?

A. Largely because they involved children with very, very high blood lead concentrations, you know. We -- again, we wouldn't use succimer to treat children with blood leads less than 45, so why go there?

The work in Yugoslavia, on the other hand, is one of the seven cohort studies that went on simultaneously around the world. It involved both children in the smelt- -- in the mining town and children in a nonexposed town who, in Pristina, P-R-I-S-T-I-N-A, Pristina, the capital city of Kosovo, where they had very low blood leads. In fact, that was one of the attractions of -- for the funders to fund this, because we had children in two towns, one town with very low blood lead concentrations and another town with high.

The low blood concentrations in Pristina were largely due to the fact that Yugoslavia was one of seven countries that signed a treaty in the 1920s to ban lead-based paint. So they didn't have lead-based paint.

And so the blood lead concentrations in Pristina were much lower than blood lead

concentrations in children in New York City.

Q. That's interesting.

And so the blood lead levels of the children in Pristina, then, did those blood lead levels -- that was your control group; is that fair to say?

A. That's fair to say.

Q. Okay. Well, we'll come back to that in just a second.

And, Doctor, I'm glad you mentioned the -- you mentioned that you were buttonholed, if you will, by the -- an epidemiologist after your talk in the late 1970s and then that lead to your getting funding working with her for this cohort study. Right?

A. That's right. But I was the lead principal investigator.

Q. Okay. And this is one of the, I think you said, seven cohort studies that were being conducted in different parts of the world?

A. That's right.

Q. Okay. And this cohort study that you were the lead on was in Yugoslavia, right?

A. Right.

Q. Okay. And is it fair to say, Doctor, that the data from this cohort study was then included in subsequent studies, including the 2005 study, I think it's called a pool study, by Dr. Lanphear?

MR. LANCIOTTI: Objection; form and foundation.

A. That is correct.

MR. TER MOLEN: Okay. Why don't we put up and we'll mark as Exhibit 5 the study, this 1982 study from Yugoslavia. Okay?

- - -

(Graziano Exhibit 5 marked.)

- - -

MR. TER MOLEN: Great. Thank you, Sam. Let's go back to the beginning here.

BY MR. TER MOLEN:

Q. You're the -- just looking at the top here, you're the second author identified on this study; is that right, Doctor?

A. That is correct.

Q. Okay. And this is the study that you were referring to, or this relates to the cohort study that you were describing in Yugoslavia; is

that right?

A. That is not correct.

Q. Okay.

A. No. This -- this paper relates to the visit that I made with funding from the World Bank. And it was at that time that I met Dusan Popovac, the first author, who was a medical doctor of some renown -- of renown. And this is describing the survey of blood lead concentrations we did in the smelter town that actually took place probably in '78 or '79.

Q. Okay. How is this different from the study you described earlier?

A. This is different because this was not a -- this was not a study that had a lot of thought going into the design. And by that, I mean we went into, with permission, clinics where children were coming in for either well childcare or they had a runny nose or some such thing. So it was what's called "a convenience sample." It was not a carefully mapped-out strategy to choose children with high, children with low. We did -- we did take blood samples from children in the same two towns, but -- so that's what this is.

Q. Okay. And when you say you did take blood lead levels in the same two towns, you mean the same two towns that were included in your longitudinal cohort study, right?

A. Correct.

Q. Okay. So why don't we --

MR. TER MOLEN: If we can go to Table 1 in this study, Sam, if you don't mind.

Thank you.

Can we -- yeah, thank you.

Q. Can you see that, Doctor?

A. I can. I haven't looked at this in a long time.

Q. Perfect.

And so just looking at the blood lead levels for the two different cities, you see the -- under the -- for 1978 -- as you said, this relates to 1978, right?

A. That's right.

Q. Okay. When you look at the "Exposed Area Residents" columns, and I guess there's also some samples from 1980, but looking at the 1978 column, you see that the exposed levels range from approximately 27 to 50 micrograms per deciliter

blood lead level; is that right?

A. That's right.

Q. Okay. And then in 1980, it's approximately 35 to 46; is that right?

A. That's right.

Q. And then the nonexposed, if you go back to the column on the far left, that's taken from the same town in Yugoslavia that you were using for your control group, right?

A. Right.

Q. And those blood lead levels range from 6.8 micrograms per deciliter to 10 micrograms per deciliter blood lead level, right?

A. That's right.

Q. Okay. So even in today's world, Doctor, we would -- well, in today's world, would you characterize even the nonexposed control blood lead levels as high?

MR. LANCIOTTI: Objection to form.

A. One needs to keep in mind that leaded gasoline was still in use at this period of time in former Yugoslavia. And so, you know, these are high by comparison to the modern day, where we no longer use lead in gasoline.

Q. Understand.

Going back at that point in time, Doctor, people of my age and your age all had much higher blood lead levels, correct?

A. That is correct.

MR. LANCIOTTI: Objection; form and foundation.

A. That is correct.

Q. Doctor, I mentioned to you that I represent a company called VNA, also known as Veolia North America.

Have you heard of Veolia North America before you got involved in this litigation?

A. No, never.

Q. Doctor, in connection with your opinions in this case, did you review the -- well, did you review a report that was prepared by a commission appointed by then-Governor Snyder of Michigan that was investigating the causes of the Flint water crisis?

A. I believe I did. Can you tell me more about what you're referring to? It was a commission that reached some recommendations; am I correct?

Q. It was a commission that was studying how the Flint water crisis occurred and making various findings, and I think also some recommendations, but more so making findings as to essentially how it happened.

A. I believe I read that, and I believe I referred to that. That's one of the references in my report.

Q. Okay. Okay. Doctor, you agree that you're not an expert in how to operate a water treatment plant, right?

A. That's right.

Q. And you're not an expert in operating a water distribution system, correct?

A. Correct.

Q. You're not an expert in the corrosion of pipes used for the distribution of water, right?

A. I'm not an expert about that, but I am certainly aware of issues. I'm aware of what New York City did years ago to start to treat water to lower water lead concentrations. I'm aware of it, but I'm not an expert.

Q. Okay. And also, you're not an expert in water chemistry; fair to say?

A. Right.

Q. In your report on Page 3 -- again, I'm happy to show this to you if you'd like -- you refer to a sequence of extremely poor engineering and policy decisions that lead to the Flint water issues.

Do you recall that?

A. I do.

Q. Okay. And you're providing that as background information; are you not?

MR. LANCIOTTI: Objection; form.

A. As background information. The failure to use anticorrosives. I am familiar with the use of anticorrosives in the New York City water supply, the addition of calcium orthophosphates to coat pipes and prevent corrosion and the elution of lead, if you will, into the water supply.

Q. I understand what you're saying, Doctor, and I just want to be clear.

You have in your report in this case -- we've marked as Exhibit 3 various opinions that we'll get to. One of my goals today is to make sure I understand what are your opinions versus what you're providing more as background here.

And I think you indicated that you're not an expert in corrosion, you're not an expert in water engineering.

So is it fair to say that you yourself are not offering an opinion as to the cause of the Flint water crisis?

A. The verbiage that I used in my report in that regard is simply a reflection of what I read in the --

Q. I understand.

A. -- report.

Q. You're repeating what others have said as opposed to offering your own opinion, right?

A. That's correct.

MR. LANCIOTTI: Objection; form.

Q. Okay. Doctor, in your report, in general, you cite to a number of scientific studies that relate to lead exposure, right?

A. Right.

Q. And we'll talk more and get to a little bit later here, you cite, for example, a 1979 study by a Dr. Needleman.

Do you recall that?

A. I sure do.

Q. And then you noted -- again, I'm happy to show this to you, but -- if that's helpful -- you note there that his study is not definitive, and then you have a parenthetical note, "because of its cross-sectional study design."

Do you recall that phrasing?

A. Yes, I do.

Q. Okay. So this, I think, would be a good time to then explain what you mean by that, if you could for us, please.

A. Surely.

A cross-sectional study, as was the case in the Needleman -- famous Needleman tooth lead study, studies the exposure and the outcome at the same moment in time. And as such, it fails to meet one important criteria one of the so-called Bradford Hill criteria for causality, and that is temporality. How could it be that today's tooth lead influences a child's performance in its classroom -- in the classroom?

So one needs -- to develop for causality, one needs to have measured the exposure before you look at the outcome. And I recall a meeting essentially at NIH when Needleman was

presenting this work and Needleman was a very -- how can I say -- he had a presence, and he pounded the table and has said -- to the experts for the paint companies and the gasoline companies, he essentially said, "Aha, we've got you now, you know, look at this powerful evidence."

And they said, "No, Dr. Needleman, you've got it all wrong. Stupid kids put their hands in their mouths. Stupid kids ingest more lead," which I always use in the classroom because it is a great teaching example of the limitations of a cross-sectional study. Really, you can't tell which is cause and which is effect.

That well-known limitation of cross-sectional studies led the National Institutes of Health to fund the Yugoslavic study, to fund the Cincinnati longitudinal cohort, to fund the Boston longitudinal cohort and so on. And so, yeah, the cross-sectional study in itself does not prove cause and effect.

Q. Okay. That's helpful, Doctor. Thank you.

And maybe just to summarize in more layman's terms, a cross-sectional study is just

looking at a snapshot in time, one moment in time, right?

A. That is right.

Q. And a longitudinal study, which I think you used that term earlier, is a study that looks at a cohort of individuals over a period of time; is that fair to say?

A. That's fair to say.

Q. Okay. And for purposes of establishing causation, you would agree that a longitudinal study is more relevant and useful than a cross-sectional study, right?

MR. LANCIOTTI: Objection; form and foundation.

A. Correct.

Q. Doctor, I'd like to talk a bit about the bellwether plaintiffs that bring us here today.

You indicated you understand that you were retained by the bellwether plaintiffs, right?

A. Right.

Q. And you were given -- or at least you had access to at one point in time, Doctor -- deposition transcripts for four guardians of bellwether plaintiffs, right?

A. Right.

Q. And it's fair to say, Doctor, that you do not discuss any bellwether plaintiffs in your report, Exhibit 3, right?

A. That's right.

Q. Sitting here today, Doctor, do you know if any of the bellwether plaintiffs had blood lead testing done during the time frame 2014 to 2015?

A. I do not.

MR. LANCIOTTI: Objection; form.

A. I do not.

Q. Sitting here today, do you know whether the homes in which any of the bellwether plaintiffs lived had lead service lines?

MR. LANCIOTTI: Objection; form.

A. I do not.

Q. Sitting here today, do you know whether the water in the homes of any of the bellwether plaintiffs was tested for lead in the time frame 2014, 2015?

MR. LANCIOTTI: Objection; form.

A. No, I do not.

Q. And you're familiar, it sounds like, Doctor, with the fact that in April of 2014, the

City of Flint changed its water source from receiving water from the City of Detroit to treating water from the Flint River?

MR. LANCIOTTI: Objection; foundation.

A. Yes, I'm familiar with that.

Q. And sitting here today, Doctor, do you know whether any of the bellwether plaintiffs kept drinking the water from the City of Flint after that switch occurred in April of 2014?

MR. LANCIOTTI: Objection; form.

A. No, I do not.

Q. Doctor, you agree that every child in America has some lead in their body?

MR. LANCIOTTI: Objection; form and foundation.

A. Yes.

Q. And you agree the same is true for the children in Flint before the water switch occurred, right?

MR. LANCIOTTI: Objection; form and foundation; outside the scope of this expert's testimony.

A. Could you repeat the question?

Q. Sure.

MR. TER MOLEN: Sara, do you mind reading that back?

(Record read as requested.)

A. I agree.

Q. Would the lead that they had -- let me start over again.

Would the lead that the children in Flint had in their bodies before the switch occurred in April of 2014 have adversely affected those children?

MR. LANCIOTTI: Objection; form and foundation.

A. Yes.

Q. Do you agree, Doctor, that before the switch of water sources occurred in April of 2014, that there was already lead in the drinking water of Flint residents?

MR. LANCIOTTI: Objection; form and foundation; outside the scope of this expert's testimony.

A. I cannot know that.

Q. I understand your response, Doctor, and that's a good segue, then, to this question, which is, can you describe for us what the primary

sources of lead exposure are in the United States?

A. Well, historically, the primary sources have been lead paint. Until not so long ago, we used lead in gasoline, and so there's lead in dust. Historically, there was lead in food much more than today because of the use of lead solder in canned foods.

But the largest source of exposure for children in the United States today is still the legacy of lead paint, which endures in many, many homes.

Q. Okay. I understand that lead paint is the largest source of exposure. Then you'd agree that over time, through lead paint deteriorating or flaking off, that lead would also accumulate in the soil?

A. Yes.

MR. LANCIOTTI: Objection; foundation.

A. Yes. In the exterior soil, yes.

Q. Yes, right.

And as you indicated, I think, through lead paint deteriorating, lead also would accumulate in dust within homes?

A. That is correct.

Q. Okay. And you mentioned that food has been a concern for lead, in part, because of lead solder in cans?

A. Yes. But that's largely historical.

Q. With respect to consumer products, Doctor, do those present any concerns with respect to lead?

A. There have been instances where pottery coming from particularly Mexico, has had lead paint on it. There have been relatively, fortunately rare, instances of toys that have appeared, usually from abroad, that have lead paint on it. It's, again, lead paint, but on a toy.

Q. Understand.

What about cosmetics?

A. There was a cosmetic called "kohl," K-O-H-L, which is a lead cosmetic that certain cultures use, largely mid-eastern, I think. But, yeah, there have been cases of lead in cosmetics.

Q. What about medicine?

A. Not that I know of.

Q. Smoking. Doctor, is smoking a source of lead?

A. Smokers have higher blood leads than nonsmokers.

Q. And secondhand smoke is also a source of lead exposure?

A. You know, I'm not sure about that. Smokers, because of their hand-to-mouth activity, have the opportunity to ingest lead dust just from their repeated hand-to-mouth activity.

I'm honestly not sure about contribution of secondhand smoke to lead exposure.

Q. Okay.

A. In children.

Q. Okay. You're familiar with Dr. Bruce Lanphear, right?

A. Yes, I am.

Q. Okay. And, in fact, you were a coauthor, is that right, of his 2005 paper?

A. That's correct.

Q. And Dr. Lanphear is an epidemiologist; is that right?

A. Pediatrician and epidemiologist, yes.

Q. And he has focused on lead exposure issues; is that right?

MR. LANCIOTTI: Objection; form and

foundation.

A. That is right.

Q. And would you agree that lead concerns is an ongoing focus of his?

MR. LANCIOTTI: Objection; form and foundation.

A. Yes, it is.

Q. Would you defer to Dr. Lanphear and his opinions with respect to whether or not secondhand smoke is a source of lead?

MR. LANCIOTTI: Objection; form and foundation.

A. He's a rigorous scientist. If he says it's a source, then I would -- but I would want to read -- if there's some peer-reviewed publication, I would want to read it --

Q. Sure.

A. -- before I buy in.

Q. Okay. Trust but verify. That's fair enough, Doctor.

A. Yeah.

Q. Do children, in your experience, Doctor, typically have exposure to lead from more than one source?

A. Yes.

Q. And, Doctor, when was lead largely phased out of the environment, at least in the U.S., if you know?

MR. LANCIOTTI: Objection; form and foundation.

A. Well, phased out of the environment? You mean phased out of leaded gasoline?

Q. Well, we can take it in steps.

When was it that lead was phased out of products in the U.S.?

A. It was largely during -- so blood leads peaked in children in the United States around 1976, '77. And at that time, we were using leaded gas and we were -- still lead paint. And a series of public health measures over time led to the banning of leaded gas, led to the banning of the use of lead paint, banning of lead solder in cans. And as a result, beginning in 1977 and onward to today, blood lead concentrations in children in the United States have declined.

I think those of us in the field, we knew that leaded gasoline was a big source. But all of us were somewhat thunderstruck by the rapid

decline in blood lead concentrations in children across the country once leaded gasoline was banned.

Q. And the leaded gasoline ban, Doctor, that occurred, is it fair to say, in the late 1970s?

A. I think that -- yeah, yes.

Q. And is it fair to say, Doctor, that in the later 1980s, there was a ban on lead in products such as paint, such as fixtures for use with plumbing, water source?

MR. LANCIOTTI: Objection; foundation.

A. I'd like to correct myself on the lead in gasoline and then we'll come back to your question.

When automobile makers start -- added the catalytic converter to automobiles, that is when there was a shift toward the use of unleaded gasoline. You may recall -- you and I are old enough -- that you would pull into the gas station and there would be leaded gas and unleaded gas. The unleaded gas was for the newer automobiles because lead fouls the catalyst in the catalytic converter.

The actual ban on leaded gasoline didn't take place until years later.

So that inflection point, from the high blood leads in 1977, coming down was due to a gradual transition away from leaded gas, but then there was -- then the policy was changed.

And now if you would repeat your next question.

Q. That's fine.

So there was a -- bans on several different products containing lead, it's fair to say, that included lead gasoline, that included lead in paint, that included using lead in fixtures associated with interior home plumbing.

And all of those bans were in place by the late 1980s; fair to say?

A. Fair to say.

MR. LANCIOTTI: Objection; form and foundation.

A. Fair to say.

Q. Okay. And is it fair to say, Doctor, that these towns with housing stock that largely predates the 1990s are more likely to have lead sources than newer homes?

MR. LANCIOTTI: Objection; form and foundation.

A. Yes, that's fair.

Q. Okay. And are you aware, Doctor, that the vast majority of homes in Flint were built before 1990?

MR. LANCIOTTI: Objection; form and foundation; outside the scope of this witness's testimony.

A. Yes, I am aware of that.

Q. Okay.

A. I have -- I have visited Flint many years ago. I've actually been there --

Q. Oh.

A. -- before any of this happened.

Q. Sure.

What was the occasion for the visit?

A. It's back when I was working on hematologic diseases. One of the diseases I worked on -- it's known as Cooley's anemia, it's known as Mediterranean anemia, it's known as thalassemia -- occurs in -- most commonly in children of Greek or Italian descent. And there was a community organization -- there was a --

quite a large cluster of such cases in Flint. And there was a community organization that invited me to speak about my work on chelating agents in -- for iron.

And so I was out there for a completely different reason, but I have been there.

Q. That's very interesting.

Approximately what time frame was that, Doctor?

A. That was 1978, '79, roughly.

Q. That's interesting.

Did you do any studies that related to the folks in Flint?

A. No. I gave a talk.

Q. Yeah.

Okay. And you'd agree, Doctor, that children who grow up in housing that predates 1990 are more likely to have higher blood lead levels than children who grow up in newer homes?

MR. LANCIOTTI: Objection; form and foundation.

A. Yes, I agree.

Q. On Page 2 of your report, Doctor -- and, again, I'm happy to show it to you if you'd

like -- I think it's more background information -- you talk about the history of Flint, and you write that "Environmental pollution descended on Flint, Michigan during the first half of the 20th century when the highly successful auto industry was producing batteries and paints and other components for automobile production."

Do you recall that?

A. I do.

Q. And obviously that pollution included lead, right?

MR. LANCIOTTI: Objection; foundation.

A. I don't know that it included lead. I say that in my -- whatever it is, Page 2, echoing comments from a colleague of mine at the School of Public Health at Columbia, David Rosner. David is a public health historian.

And I heard him give a grand rounds lecture at Columbia when the Flint issue was coming to the news and David was brought in to give a kind of a history -- lecture about the history. So I'm echoing David's -- and he is world-class public health historian.

Q. Okay. I understand. You're -- you're

repeating comments from one of your colleagues who is a historian.

You did use -- you did include in your summary of sources of pollution the production of batteries there in your report. And I think you testified earlier today that you had, in fact, been retained as an expert in a case recently, right, where you were testifying on behalf of a plaintiff who had a significant occupational exposure to lead due to working in a battery plant, right?

MR. LANCIOTTI: Objection; form.

A. Right.

Q. Okay. Is it fair to say, Doctor, you'd expect that at least the production of batteries would result in some lead pollution?

MR. LANCIOTTI: Objection; form and foundation.

A. It would result in the production of lead dust, which could be disseminated around the factory.

Q. Okay. And from the factory into the broader environment, wouldn't you expect?

MR. LANCIOTTI: Objection; form and

foundation.

A. Possibly.

Q. And are you aware, Doctor, that going back to the 19th century, the City of Flint had a municipal ordinance that required the use of lead for the service line that was feeding water into the home from the public distribution system?

MR. LANCIOTTI: Objection; form and foundation; outside the scope of testimony.

A. I did read that in one of the documents, perhaps the commission document. I'm not certain.

Q. Okay. And certainly the existence of a lead service line for the water supply for homes would be a basis for lead getting into the water. Is that not the case?

MR. LANCIOTTI: Objection; form and foundation.

A. That is the case.

Q. And you agree, Doctor, that children who live in homes with lead paint are more likely to be exposed to lead than children who do not live in homes with lead paint?

MR. LANCIOTTI: Objection; form and foundation; asked and answered.

A. Yes, I agree.

Q. Does the type of housing, in your opinion, Doctor, affect exposure to lead paint?

A. What exactly do you mean by "type of housing"?

Q. Well, there have been some studies -- and I had a discussion about this with Dr. Lanphear not too long ago -- that indicate that different kinds of housing, whether it be rental housing, whether it be housing in poor condition, are more likely, in his view, to lead to exposure of children to lead paint. That's the context, if that's helpful for you in answering the question, Doctor.

A. I would agree that housing that is not well maintained increases the likelihood that a child could be exposed to lead paint, if there is, in fact, lead paint in the residence.

Q. Okay. And by that, you mean that in a well-maintained home, the lead paint would generally be sealed or covered in ways that would minimize exposure; is that right?

MR. LANCIOTTI: Objection; form and foundation.

A. It's more likely to be encapsulated by nonlead paint.

Q. And you agree, Doctor, that some homes have lead paint on the exterior of the home?

MR. LANCIOTTI: Objection; foundation.

A. Yes.

Q. And you agree, Doctor, that on some homes, there's lead paint on fences and garages?

MR. LANCIOTTI: Objection; foundation.

A. Likely, yes.

Q. And is it fair to say, Doctor, that the more lead paint that there is in a home, that, therefore, the higher the lead dose you would expect to find in a child who lives in that home?

MR. LANCIOTTI: Objection; form and foundation.

A. I would say there's a higher probability that the child could get exposed. It doesn't guarantee that exposure would take place, but it increases the opportunity for exposure to occur.

Q. Okay. And my question, I think, is -- or the question I'm trying to ask, at least, Doctor, is slightly different, and that is getting to the level of the lead dose, if you will, right?

And so is it fair to say, Doctor, that the more lead paint there is in a home, then the higher the probability that a child living in that home will have a higher lead dose?

MR. LANCIOTTI: Objection; form and foundation.

MR. STERN: Object to form. He's already testified that the quantity of lead ingested by the child determines the dose, not the level of lead inside a particular structure. He just said it two seconds ago better than I did. Asked and answered.

BY MR. TER MOLEN:

Q. You can go ahead and answer the question, Doctor.

A. Could you repeat the question, please?

Q. Sure.

MR. TER MOLEN: Sara, do you mind reading it back?

(Record read as requested.)

A. Yes. The higher -- there would be a higher probability.

Q. You would agree, Doctor, that in an urban area like Flint with the vast majority of

the homes being built in -- before 1990, that you would expect the soil to contain lead?

MR. LANCIOTTI: Objection; form and foundation.

A. Yes.

Q. And going back just briefly to the homes, Doctor, just -- and, again, looking at a city like Flint, you'd expect that from home to home as you move through the City, there would be great variation as to the amount of lead in any particular home; is that right?

MR. LANCIOTTI: Objection; form and foundation.

A. That's right. Depending upon the conditions of the home.

Q. And with respect to water -- and by "water," I mean drinking water being supplied by the City -- you'd agree that whether or not drinking water being supplied to any given home contains lead depends on a variety of factors?

MR. LANCIOTTI: Objection; form and foundation; beyond the scope of this witness's testimony.

A. Can you ask that again, please?

Q. Sure. Let me maybe ask it a different way.

In some homes, there is lead in the drinking water. Would you agree with that?

MR. LANCIOTTI: Objection; form; foundation.

A. Yes.

Q. Okay. What are the factors, in your view, Doctor, that determine whether or not there is lead in the drinking water of any particular home?

MR. LANCIOTTI: Objection; form and foundation.

A. The factors would include, for example, whether there is lead pipe delivering water to the home, whether the main -- the lead main linking the water supply from the street to the house is a lead main; the corrosion control employed by the water supplier would have an impact on the concentration of lead in the water from those lead in pipes. It could involve the plumbing within the house, the faucets and so forth.

I think that's all I can think of.

Q. Okay. Fair enough. That's a good

summary.

And so you would agree, Doctor, that going from home to home in the City of Flint, there could be great variation as to whether or not any home had lead in its water, and if it did have lead, how much lead there was; is that fair to say?

MR. LANCIOTTI: Objection; form.

A. That's fair to say.

Q. Okay. And in this case, Doctor, it's fair to say that you haven't looked at to what degree, if any, any of the bellwether plaintiffs have been exposed to lead from paint; is that right?

MR. LANCIOTTI: Objection; form; asked and answered.

A. That's right.

Q. And you've also not -- well, let me back up here.

And sitting here today, Doctor, you're not able to opine to what degree, if any, any of the bellwether plaintiffs have been exposed to lead from water; is that right?

MR. LANCIOTTI: Objection; asked and

answered.

A. That's right. I think we already discussed that.

Q. Okay. You're familiar, I'm sure, Doctor, with the term "dose"?

A. Yes.

MR. LANCIOTTI: Objection; foundation.

A. Yes, I am.

Q. Can you explain for us what you understand that term to mean.

A. Dose is the quantity of a substance, be it a drug, be it a toxicant, that one is exposed to either by ingestion, inhalation, or dermal absorption.

Q. Okay. And do you draw a distinction between dose on the one hand and -- I'll use the word "absorption," on the other hand?

MR. LANCIOTTI: Objection; form.

A. Absorption is something else.

Q. Let me use the term "uptake." Would that help? Do you draw a distinction between the term "dose" versus "uptake"? Is that helpful or not?

MR. LANCIOTTI: Objection; form.

A. Well, let's just assume we're talking about ingestion for a moment. Forget about air and dermal.

The dose is the amount, the quantity that one swallows. Absorption can influence the fraction of that dose that actually enters the bloodstream. So they are two different things.

Q. Okay.

A. Absorption can refer to what we call the "bioavailability" of the dose.

Q. I think we're getting at the same point, Doctor, and so apologies for my layman background here. Okay? But to maybe come at this -- and if you want to treat me as a particularly slow student, feel free.

But to come at this, then, from another direction perhaps, Doctor, the -- with respect to lead, different individuals can be exposed to the same level, if you will, of lead, but their bodies might absorb different amounts from that exposure; is that fair?

MR. LANCIOTTI: Objection; form.

A. That's totally fair.

MR. STERN: Objection to form; move to

strike the colloquy.

BY MR. TER MOLEN:

Q. Can you explain for us why there would be a difference between exposure versus -- I'll call it uptake. If you want to use a different word, feel free.

MR. LANCIOTTI: Objection; form.

A. There's one classic explanation for that with regard to lead, and that has to do with iron deficiency. Children -- let me backtrack.

When one is iron deficient -- let me backtrack once more.

We typically absorb a relatively small fraction of the iron in our diets into the bloodstream. It's usually on the order of 10 percent, except for red meat. But if you eat your spinach, you're going to absorb only about 10 percent or less, perhaps.

If you are iron deficient, you absorb much more, 20, 30 percent. And we know why. We know -- on a molecular level, we know why.

When you're iron deficient, your body recognizes that you're iron deficient, and your GI -- the lining of your GI tract actually puts up

receptors for iron. There's a transporter called "divalent metal transporter." And you up-regulate that transporter in the lining of your gut. And by that means, your body takes up more iron, and that's a good thing.

The bad thing is it's not called the iron transporter. It's called the divalent metal transporter. It's not specific for iron.

So children with iron deficiency, by virtue of the fact that they have up-regulated their ability to pull in iron, unfortunately also pull in other divalent metals, including lead.

So an example here is when I worked on the succimer trials in children in New York City with substantially elevated blood lead concentrations, they often also had iron deficiency. It was not uncommon for these two conditions to co-occur.

So, yes, we vary in our ability to absorb lead and any other metals.

Q. That was a great example, Doctor, and that's exactly what I was getting at. Thank you.

And is it fair to say that for purposes of the body's uptake, that lead mimics iron for

purposes of being absorbed by the body?

MR. LANCIOTTI: Objection to form.

A. Well, I don't know that it mimics iron. It happens to have an affinity for that transporter. If you limit your analogy to that specific case, I would say yes. Once in the body, lead does not tend to interfere with iron.

Q. I understand.

A. Yeah.

Q. Understand.

Okay. And so is it fair to say, Doctor, that a child who is iron deficient, they are -- that child is more likely to absorb lead than a child who is not iron deficient, fair?

A. Yes.

MR. LANCIOTTI: Objection; form and foundation.

A. Fair.

Q. The same is true for calcium, correct?

MR. LANCIOTTI: Object to form and foundation.

A. To a much lesser extent. Calcium -- there is a literature on calcium and lead absorption. Children who are calcium deficient

could -- if the diet is deficient, and relatively deficient in calcium, it can increase the absorption of lead to a much less extent.

Q. Okay.

A. I would rank the iron deficiency situation to be much more important than calcium in the diet.

Q. Well, thank you. That's interesting. That's helpful. I hadn't heard that before.

Would you agree, Doctor, that a child who is calcium deficient is more likely to absorb lead than a child who is not calcium deficient?

MR. LANCIOTTI: Objection; form; foundation.

A. I don't know of a literature on children with calcium deficiency. Calcium deficiency is not a common thing. So I don't know of a literature, per se, of children with calcium deficiency. I do know of a literature about calcium present in the diet influencing lead absorption.

Q. And what is the upshot of that literature, Doctor?

MR. LANCIOTTI: Objection to form.

A. That a giant -- and this is known from animal studies as well, which we can do carefully -- a diet that is relatively deficient in calcium will allow lead absorption to proceed at a faster rate or more extensive -- to a greater extent.

Q. Okay. And so to ask my question differently, in a child who has a diet that is relatively deficient in calcium is more likely to absorb lead than would a child whose diet is not deficient in calcium, right?

MR. LANCIOTTI: Objection; form; foundation; asked and answered.

A. I agree with that.

Q. Okay.

MR. LANCIOTTI: Mr. Ter Molen, we've been going for close to two hours. Do you anticipate arriving at a point where we can take a short break?

MR. TER MOLEN: That's fine. Why don't we take a break. Let's see. You said we've been going for a while, Patrick. Let's come back -- and I want to get into one more point here -- but let's come back at, say, five minutes after the

hour. Take a 10-minute break.

VIDEOGRAPHER: The time is 10:54 a.m., and we're off the record.

(Recess taken.)

VIDEOGRAPHER: The time is 11:06 a.m., and we're on the record.

BY MR. TER MOLEN:

Q. Doctor, can you describe some of the variables that, in your view, affect a person's dose of lead?

MR. LANCIOTTI: Objection; form and foundation.

A. Age. Children -- young children have hand-to-mouth activity that leads them to ingest more lead; the home environment -- quality of the home environment, as we've touched on already; the housing stock, we've touched on.

In the past, when we used leaded gasolines, distance from the highway -- from the nearest highway; the nutritional variables that we've talked about, iron, and to a lesser extent, calcium.

That's what comes to mind.

Q. Okay. Thank you. That's helpful.

And you mentioned home environment and then separately, the housing stock. And I think I understand housing stock, and by that, I think you mean whether or not the home contained materials that contained lead; is that right?

A. I was referring to the age of the homes, as we've already talked about.

Q. I understand.

And I want to make sure I understand the term "home environment," if you can explain that term for me.

A. I mean the conditions, the repair -- the extent of repair or disrepair of the home.

Q. Very good.

What about genetic factors? Does that play a role?

A. No, not really. There's some small literature on -- that is not substantially convincing regarding one polymorphism from one particular protein. But, no, genetics are not really a big factor.

Q. If you were evaluating whether children in a particular home had been exposed to lead in drinking water, would it be important to you to

know whether or not that home had a filter that was used for the drinking water?

MR. LANCIOTTI: Objection; form and foundation; and beyond the scope of this expert's testimony.

A. I think it is beyond the scope of my expertise. I'm not an expert on filters. I do not -- do not know much about water filters.

Q. Okay. In your report, Doctor, you focus on five different adverse health incomes [sic], big picture; is that fair to say?

MR. LANCIOTTI: Objection to form; foundation.

A. I focused on five health outcomes, right.

Q. And I'm -- just to summarize, okay, as I read your report, those five are as follows: Number 1, neurobehavioral effects; Number 2, neurological diseases later in life; Number 3, antisocial behavior and aggression in childhood; Number 4, renal disease; and Number 5, hypertension.

Did I identify those correctly?

A. Yes.

Q. Now, for those five adverse health effects, do any of them have other causes apart from lead?

MR. LANCIOTTI: Objection; form.

Do you want to split that question up, Mr. Ter Molen?

MR. TER MOLEN: I'm fine with the question as is. I think we'll be splitting it up here momentarily, but I'm fine leaving it as is for now.

BY MR. TER MOLEN:

Q. If you understand the question, Doctor.

A. I do. I would say yes.

Q. Okay. In fact, each of those five has other adverse causes other than -- let me ask that question again.

Each of those five adverse health outcomes has causes other than lead, right?

MR. LANCIOTTI: Objection; form and foundation.

A. Yes.

Q. Okay. So let's start with hypertension. Can you identify for us other causes of hypertension?

A. Sure. Diet, body weight, body mass index, age.

Q. Okay. Very good.

And for purposes of the bellwether plaintiffs, you've not done any evaluation of these other factors; is that fair to say?

MR. LANCIOTTI: Objection; form; foundation; asked and answered.

A. That's fair to say.

Q. Thank you.

Similarly, for renal disease, Doctor, if you can identify other causes for renal disease, putting lead aside.

A. Sure. Hypertension; other environmental exposures; age. I'm not sure about genetics, but I'll stop there.

Q. Okay. And, similarly, Doctor, you've not done any evaluation of any bellwether plaintiffs for these other causes, right?

MR. LANCIOTTI: Objection; form; foundation; asked and answered.

A. That's right.

Q. Okay. Let's talk about antisocial behavior and aggression in childhood.

You'd agree, Doctor, that there are many potential causes for antisocial behavior and aggression in any particular child?

MR. LANCIOTTI: Objection; form.

A. Yes, I would.

Q. Okay. Can you identify, in your view, the primary causes of antisocial behavior and aggression in childhood?

A. I would say it's socioeconomic status; racism, bullying, parenting.

Q. Thank you.

And, similarly, as for the other two we've talked about, Doctor, you've not done any evaluation of the bellwether plaintiffs for purposes of determining whether these other causes may or may not come into play; is that right?

MR. LANCIOTTI: Objection; form; foundation; asked and answered.

A. That is right.

Q. Let's shift over to the neurological diseases later in life category, Doctor. And I believe you identify three, which are schizophrenia, Parkinson's, and essential tremor; is that right?

A. That's fair.

Q. It probably makes sense to talk about each of those three individually. Would you agree?

A. Sure.

Q. Okay. So then for schizophrenia, Doctor, what are the primary causes of schizophrenia, in your view?

A. Well, this is something I know a little bit about. There are genetic factors, but there's a significant literature about exposures or dietary deficiencies during pregnancy, during gestation, during fetal life, that predispose one to go on and develop schizophrenia. My -- I mentioned early on, the woman -- the epidemiologist who buttonholed me, as you said, and called me aside, she, Zena Stein, and her husband, Mervyn Susser, did a very, very famous in all of epidemiology landmark study, that so-called Dutch famine study. During World War II, the Dutch were essentially starved by Nazi Germany during a period of eight or 10 months or so. And Susser and Stein, the husband-wife team, studied the children who experienced the famine in fetal

life. And they followed them out into adulthood, and lo and behold, the nutritional depravation during -- just during gestation, predisposes those offspring to go on and develop schizophrenia.

So it's a very powerful line of investigation about early life exposure and developing very disabling disease later in life.

There are also genetic factors. I know Susser and Stein -- as I said, she buttonholed me -- and their son, Ezra Susser, who is my age, actually became chairman of epidemiology when I was chairman of environmental sciences, and so we've exchanged a lot of things.

I know there are genetic factors. My daughter, as an aside, adopted a child whose mother is schizophrenic, father not. And so we had many conversations before she adopted that child about what are the risks of this adopted child of going on to develop schizophrenia, which is a spectrum -- there's a spectrum, just like autism. And there's a 1-in-7 chance that a child with one schizophrenic parent could develop some -- something along the spectrum disorder, although if raised outside of the home of

schizophrenics, they do much better. So the social environment, you know -- it's interesting.

Q. That is interesting.

A. So that's -- I just told you -- it so happens my daughter is a psychiatric social worker who deals just with schizophrenics, newly diagnosed schizophrenics, so I get a lot of it at home.

Q. Right. Understand. Understand. Okay. Thank you, Doctor.

And then, similarly, you've not evaluated any of the bellwether plaintiffs for these other factors with respect to schizophrenia, right?

MR. LANCIOTTI: Objection; form; foundation; asked and answered.

A. No, I have not.

Q. Let's shift over to Parkinson's, Doctor.

What are the primary causes of Parkinson's, in your view?

A. It's a disease that's not really very well understood, not as much. There are genetic factors. Of course age. The -- you know, I've heard it said by the Parkinson's expert -- excuse

me one second.

Q. That's fine.

A. The neurologist at Columbia, who is the guru for Parkinson's disease at our institution, if you live long enough, you will get it. It's, you know, a deterioration of a certain region of the brain, and if you live long enough, it will happen. So it's a deterioration that accelerates under certain conditions.

There are known chemicals that induce syndromes like Parkinson's. Manganese -- occupational exposure to manganese, they develop early Parkin- -- what's -- something called "Parkinsonism." It's not exactly the same idiopathic Parkinson's disease, but it's a well-known risk factor.

Welders, men who work in welding and use manganese welding rods, are prone to develop a Parkinson-like syndrome. So there are -- there are known chemical exposures that do it, but aging and beyond that.

I think I've said all that I want.

Q. No, that's fine. I appreciate that.

And, similarly, Doctor, you've not

evaluated the bellwether plaintiffs for any of these factors; fair to say?

A. That's correct.

Q. Okay. And then with respect to essential tremor, Doctor, what are the primary causes, in your view, of essential tremor?

A. So here again, there are genetics and there is a chemical, a substance called harmine that induces tremor in animals, and we have it in our diets. And my colleague -- here again, the Columbia expert on essential tremor, Elan Louis, has published on exposure to that chemical.

There are also genetic risks. I can't tell you in a quantitative way, but if there's a family history, there's a greater likelihood of developing essential tremor.

Q. Okay. Similarly, Doctor, for essential tremor, you've not evaluated the bellwether plaintiffs for any of the factors that you identified, right?

A. No.

MR. LANCIOTTI: Objection; form; foundation; asked and answered.

A. No, I have not.

Q. All right. And the last category, Doctor, is neurobehavioral effects. And with respect to neurobehavioral effects, Doctor, what are the primary causes, in your view?

A. Are we limiting it to intelligence?

Q. Well, that's a very good point. Why don't we start first with if you could just define what you mean by neurobehavioral effects and we'll take it from there. Okay?

A. Well, neurobehavioral, I guess my child psychologist colleagues would cluster in there intelligence, behavior, conduct disorder. We also study motor function, which is neuro related.

Q. Okay. Anything else that you would -- as you use the term "neurobehavioral effects," anything else that you would put in that category?

A. Under that category, we have studied classroom performance, classroom behavior.

Q. Okay. Anything else?

A. Not right now.

Q. Fair enough.

Doctor, you mentioned conduct disorder, and I want to make sure I understand, because earlier we talked about, as a separate category,

antisocial behavior and aggression, right?

A. Right. Right.

Q. Would conduct disorder fit in that category?

A. I guess it would as a subset.

Q. Okay.

A. If we put it as a subset.

Q. That's fine.

Okay. Well, I'm going to break that out from the neurobehavioral effects, okay, since we already talked about that category.

Is that okay with you if we talk about --

A. That's fine.

Q. Okay. And then you also mentioned behavior, I think, in general, under the neurobehavioral effects.

Would you distinguish behavior from that same category we talked about already, antisocial behavior and aggression?

A. Well, I'm not a psychologist, but there are other dimensions of behavior that are outside of antisocial behaviors. So I -- you know, I would say there's more to behavioral issues than

just the antisocial behavior.

Q. I understand in a purer sense, that the term "behavior" isn't limited to antisocial behavior and aggression, but for purposes of studying the effects of lead on children, would you have a separate category for behavior versus antisocial behavior and aggression, Doctor?

A. I would. Here again, I would rely on my colleagues, you know. Our work on lead and this neurobehavior category has always involved significant expertise by research.

Gail Wasserman, if you read my CV, you've seen many of the papers. Gail Wasserman is actually the first author on anything having to do with this category of neurobehavior.

And I would -- frankly, Mark, I would turn to her and ask her for her opinion here rather than my sit here and --

Q. No, that's fine. I understand.

I'm really trying to get at what your opinions are, Doctor, so let me come at this another way.

Is it fair to say that for your opinions in this case, Doctor, when you talk about

neurobehavioral effects as distinct from the other categories that we've talked about, that you're talking about intelligence?

A. Yes. That's the prime component that I'd like to talk about, yes.

Q. That's fine. Well, why don't we talk about that, then.

So focusing on neurobehavioral effects, then, Doctor, with respect to intelligence, which is the focus of your opinions, what other causes, putting lead exposure aside, are there in your view for neurobehavioral effects?

A. We're just talking about intelligence now, correct?

Q. Yes, we are.

A. Yeah. Well, there are -- there are a long list of them, and these are the so-called confounding variables that we consider whenever we do an analysis of the relationship between lead -- blood lead and child intelligence.

To -- to list them, one is quality of the home-rearing environment. And there is an assessment, it's called Caldwell's HOME. It's an assessment one does. You go into the home and

you -- it's a structured interview of -- typically of mom or the primary caretaker, and you interview the caretaker about many aspects of the child's daily life. Do you take the child to -- shopping with you? To what extent does the child have exposure -- normal exposure? How many books does the child have? How many toys does the child have? Is the child's art hanging on the wall? You know, these are indicators -- is there a clock on the wall, believe it or not? These are indicators of sort of the quality of the home environment.

Another one is birth order. First-born children do better. Why is that? Well, let me backtrack.

So the developing brain in an infant -- the developing brain has the most neuronal connections at the age of 1. And then brain actually begins trimming back neuronal connections. And it's -- there's a term for it -- I'm blocking on the word -- but in any case, it's pruning. It is literally pruning back. And how does the brain know? Which neuronal connections do you keep and which ones do you discard? Well,

you keep the ones that are being used. And so this is one of the reasons why this social-to-home environment, the social stimulation, actually helps kids retain neuronal connections. In the absence of social stimulation, there's a dissipation of that.

So birth order plays right into that. Think about -- I don't know -- I have three children. First-born child gets all of the attention. You read to the child, you know. You take a thousand photographs of the child, you know, the first child. You know, the second one gets a little less attention, third one less, and so on. So being born ahead of the rest of the pack is actually beneficial. And so we always control for birth order.

Mother's education here again and mother's age play into the ability of the mom to socially engage the child, intellectually engage the child. So it's well known that women of lower education are more likely to have children who do relatively poorly. It makes some logical sense.

Mother's age. Very young mom does not do as well in giving a child stimulation and so

on.

Marital status is a variable that we always take into account. Single mom or dad has much more of a challenge of providing a child with the social stimulation.

Prenatal smoking, prenatal alcohol abuse.

So these are some of the factors that are known to influence a child's intelligence, and these are the very factors that we statistically adjust for as you, I'm sure, by now well know having read the Lanphear papers and others -- and my own.

Q. Yes. Thank you, Doctor. I have a bit of a layman education here.

And with the various factors you've described, it's fair to say, Doctor, as we've talked about for the other categories here, is that you've not evaluated any of the bellwether plaintiffs for the existence of these factors, right?

MR. LANCIOTTI: Objection; form; foundation; asked and answered.

A. No, I have not.

Q. And you'd agree, Doctor, that to determine what degree, if any, lead had contributed -- let me start over again.

You would agree, Doctor, that to determine whether or not exposure to lead had contributed to an effect on intelligence for any particular individual, that one would need to evaluate and understand all of the different factors you've identified, right?

MR. LANCIOTTI: Objection; form; foundation.

A. Correct.

MR. TER MOLEN: I'd like to introduce a document -- I think we're at Exhibit 6 now -- which is from the year 2000, and it's with respect to, I believe, your Yugoslavia work. The primary author, I believe, is a gentleman by the name of Wasserman.

A. It's a woman. Gail.

Q. Oh, thank you. Appreciate that.

- - -

(Graziano Exhibit 6 marked.)

- - -

MR. TER MOLEN: Thank you, Sam.

If you could maybe blow -- yeah, thanks.

THE WITNESS: Could I just read the abstract for a second just to give me a...

Okay.

MR. TER MOLEN: Do you mind just scrolling through just quickly, Sam, and we'll -- yeah, thank you.

THE WITNESS: Could you just go back -- just let me look at this. We've published many papers together. I just want to get a sense of which one this is.

Can I see the figures, please?

And the next figure, please?

Okay.

BY MR. TER MOLEN:

Q. Okay. So, Doctor, you recognize this document that we've marked as Exhibit 6 as a paper that you coauthored, right?

A. 20 years ago. Yes.

Q. I'm not going to ask you to recite it chapter and verse, Doctor.

And this paper relates to the Yugoslavia cohort study that you talked about earlier, right?

MR. LANCIOTTI: Objection; form.

A. That's correct.

Q. Okay.

MR. TER MOLEN: Let's go to Page 817, if you don't mind, Sam.

Q. Okay. And there is some specific language here that I'm looking at. If we go just above to that paragraph that's just above "Acknowledgments" on the right side.

Do you see that?

A. Yes.

Q. And then -- let me make sure I've got it -- you see the first sentence there, "in summary"?

A. Yes.

MR. TER MOLEN: We'll come back, Sam, in a second to the other language here.

Q. But "In summary, in the present setting, elevations in both prenatal and postnatal blood lead levels are independently associated with small decrements in young children's intelligence."

Do you see that?

A. Yes.

Q. Okay. Bear with me a minute. I just

want to find some additional language here.

MR. TER MOLEN: Can you scroll down just a little bit.

Q. Yeah, the bottom left here -- the paragraph that starts at the bottom left?

Do you see that, Doctor? You say "We estimate that relatively high levels of lead are associated with relatively small decrements of IQ."

Do you see that?

A. Yes, I do.

Q. Okay. And do you agree with that today?

A. Yes, I do. 20 years ago, this was what we believed.

Q. Okay. What --

A. Much has happened -- much has happened in the ensuing two decades.

Q. And this study was focused on blood lead levels that were -- as I think you can see there later on in the same paragraph, that were above 10 micrograms per deciliter, right?

MR. LANCIOTTI: Objection; foundation; form.

A. Just allow me to read it, please.

Well, let me make a comment here. The Yugoslavia study did not, of course, only include children with very high blood leads. It included children with very low blood leads as well in the Pristina city where exposures were very, very low.

We used this window of 10 to 30 micrograms per deciliter just to illustrate that this is what can happen if blood leads go from 10 -- you know, a child -- child with a blood lead of 30 would have 4.3 IQ points less than a child with a blood lead of 10. Let's just use that as a means of giving the reader some sense of the magnitude of the loss in IQ for children in that range.

Since this paper 20 years ago, though, much has been learned, largely as a result of the pooled analysis, which I'm sure we're going to come to, the Lanphear papers, that allow scientists today to make stronger conclusions about blood leads in the low range.

Keep in mind, of the seven prospective studies, the Yugoslavia study, because it, you know, involves a smelter population, does have a range of blood leads that is the widest and the

highest. That's not to say that we didn't have children in the very low range.

But the pooled analysis allows us to reach much stronger inferences and conclusions about the consequences of exposure in the low range.

I could go on if you'll allow me.

Q. Well, we'll certainly get to the pooled analysis later, Doctor.

A. Okay.

Q. And believe me, you'll get a chance to discuss the more recent literature. I just want to make sure I understand this study.

And I understand what you said, that as you saw blood lead levels increase from 10 micrograms per deciliter to 30 micrograms per deciliter, that that increase correlated with an IQ decrement of 4.3 points, right?

MR. LANCIOTTI: Objection; form; asked and answered.

A. Allow me to clarify one thing here.

The tests of intelligence that were used here and in all of the other prospective studies were never tested on a very, very large sample of

children in Yugoslavia. It was never totally standardized, you know. How do we standardize an IQ test? We administer it -- here in the United States, you administer to a thousand or 10,000, I don't know, children. You devise the distribution, you observe the distribution of scores, and then you assign the average score of an IQ of a hundred. And then the standard deviation is 15, and so the -- that was never done in Yugoslavia. So we relied on U.S. standards to -- which is a leap. We more often refer to actually the test scores rather than IQ.

My point is this estimate of IQ is somewhat biased by the fact -- and smaller -- due to the fact that the test was never actually standardized on many, many thousands of children.

Q. Okay. Doctor, in this paper, do you note that this result is biased and not standardized?

MR. LANCIOTTI: Objection; form.

A. I am sure that somewhere in the paper, it says something to that effect, that earlier in the methods, that we're -- that the test has not been -- you know, we're using U.S. standards.

Q. I understand.

Okay. And understanding that qualification, Doctor, what you conclude in the paper is that an increase in blood lead levels from 10 micrograms per deciliter to 30 micrograms per deciliter resulted in an IQ decrement of 4.3 points, right?

MR. LANCIOTTI: Objection; form; foundation; asked and answered for the third time.

A. That is right. However, let me qualify. Since this time, 20 years ago, we've learned a great deal more about the relationship between blood lead and IQ in the range of zero to 10.

Q. I understand.

MR. TER MOLEN: Okay. All right. Let's go to the top of the page on the right side here, right?

Q. And then you note -- at the top here, Doctor, in the sentence that starts at the end of the second line, top of the page, you note that, "In comparison, social factors, such as those measured here, have considerably stronger associations with child IQ, both in our own and in others' work."

A. Absolutely.
Q. You absolutely agree with that, right?
A. I agree with that.
Q. And the intervening literature in the last 20 years has just confirmed that point, correct?
MR. LANCIOTTI: Objection; foundation.
A. That's correct. If you look at -- we go on to talk about the percent of the variance in IQ. There are other factors that I listed before we got into this conversation that account for more of the variance in IQ than lead.
Q. Right.
A. Lead is a player, but there are many other players that impact IQ.
Q. That's right.
And compared to social factors, Doctor, you'd agree that lead is a very minor player, right?
MR. LANCIOTTI: Objection; form; foundation.
A. That is right.
Q. Okay. Doctor, as well as social factors, you agree that there are a number of

other chemicals besides lead that can be associated with a decreased or decrement of IQ, right?

MR. LANCIOTTI: Objection; foundation.

A. Right.

Q. Can you identify those for me, please.

A. Chemical insults? Oh, my. The list is long.

So there are chemicals such as PCBs, polychlorinated biphenyls; there are chemicals such as manganese that I mentioned earlier; there are chemicals such as arsenic; there are chemicals such as plasticizers. I mean, there's a book -- well, I -- never mind. I won't go into it.

But there are many, many chemicals, just to name a few.

Q. Okay. Would you include mercury?

A. Yes, I would.

Q. Are you familiar with the term organophosphates?

A. Absolutely. Organophosphate pesticides. Much work done at my own institution.

Q. Okay. You mentioned PCBs.

What about, another acronym here,

Doctor, PBDEs?

A. Those are flame retardants, yes, also.

Q. Okay. And it's fair to say, Doctor, that you haven't evaluated any of the bellwether plaintiffs for their exposure to any of these chemicals, correct?

MR. LANCIOTTI: Objection; form; foundation; asked and answered.

A. Correct.

Q. And we'll be talking more about the various studies that you cite in your report and others that relate to low-level lead exposure, Doctor.

But sitting here today, are you aware of any epidemiological studies of lead affecting children's IQ that control for exposure to any of these other substances?

MR. LANCIOTTI: Objection; form.

A. Not for all of them but for some of them.

Q. Okay. So sitting here today, you're not aware of any study investigating the association between exposure to lead and loss of IQ in a child that exposes for potential exposure to all of the

substances we've described that can also affect IQ; is that right?

MR. LANCIOTTI: Objection; form; asked and answered.

A. That's right. And, parenthetically, that work is happening now.

Q. Who is doing that work, if you know?

A. Frederica Perera, who is the former head, the founder of the Columbia Children's Center for Environmental Health. They have followed a birth cohort, births in northern Manhattan and South Bronx for -- they just celebrated their 20th anniversary, the center. So their participants are in their late teens.

They have, in fact, measured many, if not all of the list that you just mentioned. And because, as I mentioned earlier, the statistical methodology to study mixtures has now evolved, they're in the thick of it right now doing exactly that work.

Q. When do they expect to publish, if you know?

A. Oh, it's just in its formative stages. But I know that there are several people working

on that full-time, including postdoctoral fellow and a Ph.D. -- brilliant Ph.D. student, and one of our young assistant professors.

Q. When you say "just in its formative stages," I take it you mean the publication is years away, if you know?

MR. LANCIOTTI: Objection to form.

A. Probably years away. They're just assembling this enormous dataset which is being derived from various studies that they've done. So that may sound like an easy task, but it's not.

Q. I understand. Thank you. Appreciate it.

Doctor, there's a term that I've come to be somewhat familiar with in the context of trying to learn a bit about your work that is -- well, and that term is "nonspecific conditions."

Can you define what that term means to you?

A. I don't know what the context of your question is.

Q. Sure.

How about this. If we put it in the context of epidemiology, does that help?

A. Not really.
Q. Okay.
A. Sorry.
Q. How about if I put it this way, that I understand the term "nonspecific conditions" to mean conditions for which there are multiple potential causes.
MR. LANCIOTTI: Is there a question pending?
Q. Would you agree with that definition?
MR. LANCIOTTI: Objection; form.
A. I'm having a hard time understanding. Forgive me.
Q. That's quite all right.
Let me put it this way. If -- would you agree, Doctor, that in order to attribute an adverse health outcome in a particular individual to lead exposure, that you would have to perform a differential diagnosis to rule out other potential causes?
MR. LANCIOTTI: Objection; foundation.
A. I think that's fair. But, as we said, you know, IQ -- loss of IQ, how does one even perform a differential diagnosis because of the

large number of variables involved?

Q. It becomes certainly very difficult unless you've done a thorough assessment of all of the variables, right?

MR. LANCIOTTI: Objection; form.

A. That's fair.

Q. And with respect to evaluating loss of IQ, you were earlier talking about potential issues with the Yugoslavian study.

To evaluate any loss of IQ, isn't it fair to say that you would need a control group, some form of a baseline?

MR. LANCIOTTI: Objection; foundation.

A. You know, what the epidemiology studies allow one to do, they allow one to say, on average -- on average, a child with a blood lead of this compared to blood lead of that would lose, on average, this number of IQ points.

Epidemiology does not allow you to go and talk about an individual child. That's not what it is capable of doing.

Q. And as you're saying, Doctor, the epidemiological studies are looking at populations as compared to individuals, right?

MR. LANCIOTTI: Objection; form.

A. Population of individuals, right.

Q. They're at the population level, not the individual level, right?

A. Right.

Q. And so to fully understand any particular epidemiological study, you'd need to understand what the baseline is for the population level that was being studied, right?

A. Right.

MR. LANCIOTTI: Objection; form; beyond the scope of this witness's knowledge.

Q. And a population-level study done in Manhattan, for example, might have a quite different baseline than the population-level study done of the Bronx; is that fair to say?

MR. LANCIOTTI: Objection; form.

A. That's fair to say, and that is precisely why the Lanphear pooled analysis coming from many, many different countries and cities within the United States is so important.

Q. Right. We will get there. I promise, Doctor.

A. Oh, I'm sure.

Q. Doctor, I'd like to identify some conditions in addition to those that we've discussed today and then understand your view of any link between these conditions and lead exposure. Okay?

A. Sure.

Q. So rhinitis. Are you familiar with that term?

A. Yes.

Q. Is rhinitis, in your view, linked to lead exposure?

MR. LANCIOTTI: Objection; form.

A. Not to my knowledge.

Q. Shortness of breath. Is shortness of breath linked to lead exposure?

MR. LANCIOTTI: Objection; form.

A. Not to my knowledge.

Q. Skin rashes. Are skin rashes linked, in your view, to lead exposure?

MR. LANCIOTTI: Objection; form.

A. No.

Q. Hair loss. Is hair loss linked, in your view, to lead exposure?

MR. LANCIOTTI: Objection; form.

A. Not that I know of.

Q. Nerve pain. Is nerve pain linked, in your view, to lead exposure?

MR. LANCIOTTI: Objection; form.

A. So adults with occupational lead poisoning can experience nerve pain.

Q. Okay.

A. I don't know of any such literature in children.

Q. Thank you. Sorry to cut you off, Doctor.

By "occupational exposure," I take it that you mean -- we're talking about blood lead levels in excess of, say, 15 micrograms per deciliter?

MR. LANCIOTTI: Objection; form; foundation.

A. Yes.

Q. Exhaustion. Is exhaustion, in your view, linked to lead exposure?

MR. LANCIOTTI: Objection; form.

A. Well, fatigue. I don't know I would use the word "exhaustion," but fatigue, yes.

Q. All right. And at what levels of lead

exposure, in your view, is fatigue linked to lead exposure?

MR. LANCIOTTI: Objection; form.

A. Greater than 30.

Q. And that by "30," you mean 30 micrograms per deciliter?

A. 30 micrograms per deciliter, yes.

Q. What about memory loss? Is memory loss associated with lead exposure?

MR. LANCIOTTI: Objection; form.

A. Well, it certainly is, again, at high blood lead levels.

Q. Okay. Again, above 30 micrograms per deciliter?

A. Yes.

Q. What about blackouts? In your view, Doctor, do people experience blackouts in association with lead exposure?

MR. LANCIOTTI: Objection; form.

A. Yes, but only when the blood lead is exceedingly high.

Q. Okay. With respect to depression, Doctor, is depression a condition that, in your view, is linked to lead exposure?

MR. LANCIOTTI: Objection; form.

A. Not that I know of.

Q. Okay. Chronic anxiety, Doctor? Is chronic anxiety, in your view, linked to lead exposure?

MR. LANCIOTTI: Objection; form.

A. Not that I know of.

Q. Post-traumatic stress disorder. Doctor, is that a condition that, in your view, is linked to lead exposure?

MR. LANCIOTTI: Objection to form.

A. No.

Q. Forgetfulness, Doctor. Is that a condition that is linked, in your view, to lead exposure?

MR. LANCIOTTI: Objection to form.

A. Well, memory is a component of some of the assessments we have done. Yes, I would say short-term memory is one of the outcomes that has been investigated with regard to lead.

Q. Certainly in the context of, for example, Parkinson's, short-term memory can be an issue. Outside of a condition like that, Doctor, in your view, is there a link between short-term

memory issues and lead exposure?

MR. LANCIOTTI: Objection; form.

A. I'm trying to recall work from 20 years ago, and it's not easy.

I'm going to be -- I'm going to equivocate on this one, if you don't mind.

Q. That's fine. That's fine.

And the work that you're trying to recall, Doctor, understanding that you're trying to recall it, was that focused on adults as opposed to children?

A. Children.

Q. On children. Okay.

So sitting here today, it's fair to say you're just not sure; is that fair?

A. That's fair.

Q. Okay. With respect to Alzheimer's, Doctor, is there a link, in your view, between Alzheimer's and lead exposure?

A. No.

MR. LANCIOTTI: Objection; form.

Q. I'd like to talk about the methodology that you used in putting together your report in this case that we've marked as Exhibit 3. Okay?

A. Yes, sir.

Q. On Page 3 of your report -- and, again, I'm happy to show it to you -- you talk about providing a, quote, unquote, brief review of the scientific literature that points to, and you use the phrase, causal and/or suggestive links between lead exposure and adverse health outcomes in children. Okay?

A. Yes, sir.

Q. And what do you mean by the term "brief review"?

A. Well, I had the good fortune in this case to have been armed with fairly massive systemic reviews of the literature done both by -- in particular, by ATSDR and by -- and somewhat earlier than that, by EPA. And this panel of scientists, experts, one of whom, for example -- you mentioned Wasserman, Gail Wasserman. My colleague was one of the many scientists involved in these reviews. But they had undergone -- because lead is covered under the Clean Air Act, it's one of the priority pollutants under the Clean Air Act.

It is regular -- on regular intervals,

the literature is reviewed to see whether, for example, the EPA criteria for lead in air is sufficiently protective of the public.

So it had these government agencies do these massive reviews just recently, and what's -- so I took advantage of that. I could have set about and done my own systematic review of the literature, which would have taken a year and a half to do it adequately. It took these committees that much time, or longer, to actually achieve what they did. And so I -- by saying whatever the words were briefly, I tried to reflect the incredible amount of work that went into these systematic reviews of literature rather than reinvent the wheel, and I couldn't possibly reinvent the wheel as well as they had done.

Is that clear?

Q. Okay. That's fair enough, Doctor. I appreciate that.

Then on Page 11 of your report -- and shifting gears from a general discussion of the lead-related scientific literature to a more specific focus of the scientific literature related to low-level lead exposure, okay, you say

there in that first paragraph under 4 -- let's see -- six lines up from the bottom of that first paragraph, you say "I", meaning you, "believe that I have provided a fair representation of the scientific literature concerning, for the most part, low-level lead exposure in the range that has been experienced by the children of Flint," right?

A. Right.

Q. Okay. And what do you mean by the term "fair representation" as you use it in that sentence?

A. I haven't cherry-picked. I haven't ignored, you know, opinions that -- well, just that. I haven't cherry-picked.

Q. Okay.

A. And, you know, I must say that the ATSDR and EPA massive reviews did consider all of the literature, whether it was reaching -- with the -- let me -- I'm sorry.

They did consider all of the literature. They, too, didn't cherry-pick just the studies that they felt would lead to the conclusions that they reached.

Q. Okay. Are there studies that reached different conclusions from your report as to whether low-level lead exposures caused the health effects discussed in your report?

A. I think there are studies that reach different dose-response relationships. I don't know of any study in the past 20 years that is credibly peer reviewed that says there's no effect of lead on child intelligence. They may argue about methodology and did you control for this or did you control for that. But I don't know -- that's not the case.

Going back in time before the prospective studies, surely there were small studies, case control studies, cross-sectional studies that might have reached the conclusion that there is no association between blood lead and child intelligence. That's before the era of doing the modern longitudinal epi studies that have been done.

Q. Okay. I understand, Doctor.

And it's a -- it is a broad area, but just to try to zero in on a specific area that I think is of interest to both of us, let's talk

about studies that are looking at effects on intelligence in children of blood lead levels less than 5 micrograms per deciliter. Okay?

A. Okay.

Q. Okay. Sitting here today, are you aware of any studies that have not found an association between blood lead levels less than 5 micrograms per deciliter and children's intelligence?

A. I am not.

Q. Okay. And you've identified the two extensive studies that you've relied on as having done a systematic review of the scientific literature with respect to lead exposure and health effects, right?

A. That's correct. Particularly the ATSDR report of just recent, 2019.

Q. Okay. And do you know what methods the ATSDR committee used to reach their conclusions?

A. Well, they do spell out in considerable detail the criteria they used for reaching causal -- conclusions of causality. And I can't reiterate them off the top of my head, but there is a section of the document devoted to their causal inference, referring undoubtedly to the

Bradford Hill criteria.

Q. Okay. And just so we're clear, Doctor, picking up on the terms that you just used there, and I think you've got this terminology on Page 4 of your report, where you use the phrase "casual and/or suggestive links."

Do you recall using that phrase?

A. Oh, definitely. And I went through the five health outcomes that you enumerated early on. And by no means do I conclude that all of them reach the Bradford Hill criteria for causality, and I specifically mention that in my summary.

Q. You certainly do, yeah.

Can you explain, in your view, the difference between a causal link versus a suggestive link?

A. Sure. The literature -- for those outcomes where I think it's suggestive, is considerable but has not reached the -- sufficient number of the Bradford Hill criteria for us to come down and, you know, put the hammer down and say "This is causally related." I would have been derelict, I think, if I didn't mention health outcomes outside of child intelligence because it

is conceivable, given the state of knowledge, that they could arise -- they could -- as time evolves, they could be a consequence of early lead exposure.

So I felt I was being fair in bringing them before counsel.

Q. I appreciate that.

And just to, again, put it in my own words, Doctor, the -- in your view, science has established a causal link between lead exposure and effects on intelligence in children, right?

A. Right.

Q. Okay. And putting aside effects on intelligence, in your view, in its current state, the scientific literature has not established a causal link between lead exposure and any other adverse health effects in children, right?

MR. LANCIOTTI: Objection; form; foundation.

A. As of today, that is right, although I think the evidence moving forward about behavior is considerable. But as of today, I don't -- I don't disagree with that.

Q. I understand. Appreciate that.

There have several places in your report, Doctor -- and I'm happy to show you specific pages if that's helpful -- where you refer to the -- or where you use the phrase "weight of the evidence."

Do you recall using that phrase?

A. I do.

Q. Can you explain what you mean by that phrase?

A. So it comes down, again, to the Bradford Hill criteria. So Bradford Hill talked about a number of criteria that are required. If one looks at the literature, if one looks at the weight of the evidence, you want to see certain parameters validated. What is the consistency of the observation across many studies? What's the temporality? Did the exposure occur before the outcome? Is there a biological gradient, a dose-response relationship? Is there biological plausibility? Is there experimental evidence in nonhuman species?

So this is what I refer to as the weight of the evidence. And, of course, the weight of the evidence when it comes to the literature in

experimental animals is very, very large with regard to the very five health outcomes -- except for criminal behavior -- I don't think we have criminal behavior among rats -- but the weight of the evidence on the biological side, biological plausibility, the mechanism of action, all of these play into what I call the weight of the evidence.

Q. Okay. And that's a phrase that you're using when you're looking at literature that's relating to evaluating potential associations between lead exposures and health outcomes other than on effect on intelligence, right?

A. Right.

Q. Okay. We've talked about the Bradford Hill criteria, Doctor. And my understanding, there are nine different criteria.

Does that sound correct to you?

A. And here they are (indicating).

Q. Okay. Very good. It looked like you were referring to some notes earlier.

Do you want to just list them out for us, Doctor?

A. Say again?

Q. Do you mind just listing them out for us.

A. Sure.

Strength of the association; consistency of the findings; specificity of the findings; temporality; biological gradient; coherence; biological plausibility; experimental evidence; and analogy.

Q. Did you yourself apply those criteria when you were evaluating in your opinion the literature with respect to use the term "low-level lead exposure" and effects on intelligence?

A. Yes, I did.

Q. Okay. You don't do that specifically in your report, right?

A. I did not enumerate them one by one, no.

But bear in mind, I've lived this literature. I've lived through it personally by doing investigations, annual meetings of Society of Toxicology and so on.

And so I have seen this evolve over time going back to the days when there was deny, deny, deny by the lead industry experts and the gasoline industry experts. Deny, deny, deny.

Q. Appreciate that.

MR. TER MOLEN: You know, we're at a -- from my standpoint -- I'm happy to keep going, but we're also at a good stopping point for me, and I know East Coast time it's about 12:15.

Should we take a break now for lunch? Does that work for people?

THE WITNESS: Certainly works for me.

MR. TER MOLEN: Okay. Why don't we plan to take, let's say, 45 minutes, and we'll come back at the top of the hour then. Okay?

VIDEOGRAPHER: The time is 12:15 p.m., and we're off the record.

- - -

Thereupon, the luncheon recess was taken at 12:15 p.m.

- - -

OCTOBER 29, 2020

THURSDAY AFTERNOON SESSION

1:00 P.M.

- - -

VIDEOGRAPHER: The time is 1:00 p.m., and we're on the record.

BY MR. TER MOLEN:

Q. Doctor, I'd like to look briefly at a couple of studies that relate to the discussion that we had on low-level lead. The first I'm going to show you is a study published in 2017 with Taylor as the lead author.

MR. TER MOLEN: So, Sam, if you're able to put that one up. Thank you.

We'll mark this as Exhibit 7, I think.

- - -

(Graziano Exhibit 7 marked.)

- - -

BY MR. TER MOLEN:

Q. Doctor, this document that we've marked as Exhibit 7 is, as I said, published in the journal, NeuroToxicology.

Are you familiar with that journal?

A. I am. It's not something I read

regularly, but yes.

Q. It's a reputable journal?

A. Yes, it is.

Q. And the title of this is "Effects of Low-Level Prenatal Lead Exposure on Child IQ at 4 and 8 years in a UK Birth Cohort Study," right?

A. Yep.

Q. And the lead author is a Ms. Caroline Taylor, right?

A. Yes.

Q. Are you familiar with her?

A. No.

Q. Are you familiar with any of the authors identified in Exhibit --

A. No, I am not.

Q. -- 7?

Okay. Is this a study that you looked at for purposes of your opinion, Doctor?

A. No, it is not.

Q. And can you tell me why that is since this is looking at low-level prenatal lead exposure and that's a topic on which your opinion touches?

A. I -- I cannot. I missed it.

Q. Okay. You would have liked to have reviewed this and included this in your opinion, right?

MR. LANCIOTTI: Objection; form and foundation.

A. Yes. I -- I would have to go back to the ATSDR document, which was a 2019 publication, and see whether -- how they consider this, but...

MR. LANCIOTTI: Dr. Graziano, if you need to review this article before answering any questions, please take the time you need.

THE WITNESS: Oh. I would not mind that at all. May I have that ability?

MR. TER MOLEN: Sure. Take your time, Doctor. We can scroll through.

Sam, do you mind just kind of scrolling through quickly to the end so we get a sense of the overall length.

And then we can work through this at your leisure, Doctor.

THE WITNESS: Well, given the length, I'm not going to be able to digest this quickly.

BY MR. TER MOLEN:

Q. Okay. I understand.

If we can turn to Page 167 of this, please. Thank you.

And then they break down the scoring into boys and girls, right?

A. Right.

Q. And then would it surprise you, Doctor, that this study actually finds an inverse relationship between the exposure to lead on the one hand and IQ on the other amongst girls?

MR. LANCIOTTI: Objection; form; foundation.

A. Yes. That runs counter to everything that's been seen in other literature.

Q. Sure. It does, indeed.

But, again, we're talking very low levels here.

Okay. I understand you haven't had a chance to look at this.

We'll put up another document -- another study that we'll mark as Exhibit 8.

(Graziano Exhibit 8 marked.)

- - -

BY MR. TER MOLEN:

Q. This is a 2018 study. The lead

author -- and I may massacre this -- is Desrochers-Couture.

Do you see that?

A. I do.

Q. Okay. Are you familiar with the lead author?

A. No, I'm not.

Q. Okay. Are you familiar with any of the authors?

A. Bruce Lanphear.

Q. Indeed.

MR. TER MOLEN: If you can scroll up, Sam. A little bit higher. Thank you.

Q. This is a publication called Environment International, correct?

A. Yes.

Q. Are you familiar with that publication?

A. Yes.

Q. Is it a reputable publication?

A. Yes. It's okay.

Q. And this is titled "Prenatal, Concurrent, and Sex-Specific Associations Between Blood Lead Concentrations and IQ in Preschool Canadian Children," right?

A. Yes.

Q. Have you seen this article before today?

A. No.

Q. Okay. Obviously, this is quite recent research looking at the association between blood lead levels and children, correct?

A. That's correct.

Q. Okay. And is this something that you wish you had looked at for purposes of your opinion in this case?

MR. LANCIOTTI: Objection; form; foundation. He just testified that he hasn't reviewed this article. He hasn't seen it yet.

You can answer.

A. Yes.

Q. Okay. And sitting here today, do you know why it is that you haven't seen this article?

MR. LANCIOTTI: Objection; form; foundation.

A. As I said, I did not do an extensive systematic review of the literature. I relied on the ATSDR systematic review of the literature which was published in 2019. And here again, I'm surprised that they didn't pick it up either.

Q. Okay. And do you see what the objective is? The objective here, looking under the "Abstract," is to test the associations between blood lead concentrations and cognitive function in Canadian preschoolers.

Do you see that?

A. Yes.

Q. Okay. And that objective, obviously, is directly relevant to your opinions, correct?

MR. LANCIOTTI: Objection; form; foundation.

A. Yes.

Q. And then if you go down under "Results" there, do you see that? It says "Median blood lead concentrations for the mother at first trimester and third trimester of pregnancy and for cord and child blood were 0.6 micrograms per deciliter, 0.58 micrograms per deciliter, 0.79 micrograms per deciliter, and 0.67 micrograms per deciliter, respectively. We found no association between cord blood concentrations and intelligence scores in multivariable analysis."

Did I read that correctly?

A. Yes.

And I just would add that these are astonishingly low blood lead concentrations bordering on the limit of detection of the method. These are all less than 1.

Q. Yes.

A. Not only less than 5, but they are less than 1.

Q. Right.

Okay. And, Doctor, is it fair to say that based on all of your experience and years of study, that if a blood lead level is less than 1, you would not expect to have any effect on intelligence?

MR. LANCIOTTI: Objection; form; foundation.

A. I'm not surprised that a blood lead less than 1 has no effect on intelligence, you know. These do not -- these do not really reflect anthropomorphic sources of lead, you know. If you look at populations who live in the mountains of Nepal where the only -- you know, the only exposure they get is from volcanic eruptions, these are the kinds of blood lead levels that one sees.

So this -- these blood levels do -- are just -- are astonishingly low.

Q. Okay. I appreciate that.

And, again, just to go back to my question, I just want to make sure I understand what your answer was.

You would expect that blood lead levels between 1 microgram per deciliter do not indicate an effect on intelligence in children, right?

A. I'm not --

MR. LANCIOTTI: Objection; form; asked and answered.

A. I'm not at all surprised. I don't know what you use as your control comparison. Is it children who have negative numbers?

Q. I understand. Understand.

Okay. And if the same results had come back, Doctor, when you read the last sentence there under "Results," it says "No associations were found between intelligence scores and prenatal maternal blood or concurrent child blood lead concentrations," right?

A. Right.

Q. And if the blood lead levels had been

2 micrograms per deciliter or lower, you would not have been surprised at the exact same finding of no association, right?

A. I would not --

MR. LANCIOTTI: Objection to form. He's not the author of this study.

A. I would not say that, Mark.

Q. You would not say that. Okay.

What would you say?

A. I would say that there is -- I know we'll come to it -- the pooled analysis which looks at a very large number of children in the low blood lead range, below 5, and we see a striking dose-response relationship. These blood leads are far below, I would dare say, any that were observed in the pooled analysis, so...

Q. Okay. And, you know, there's a -- would you expect, Doctor, that there is some threshold of blood lead level before there is an adverse effect on child intelligence?

MR. LANCIOTTI: Object to form.

A. We have not ever seen any. The EPA has concluded that there is no threshold; there is no safe level of lead.

Q. Well, it's fair to say, Doctor, I think you're maybe stating it a little differently than what the language is, right? I mean, the language is there has not been a safe level that's been identified, right?

A. That's correct.

Q. Okay. And looking at these results here, your reaction to these results indicates that you're not surprised that there has been no observed effect at the blood lead levels less than 1 microgram per deciliter reflected here, right?

MR. LANCIOTTI: Object to form.

A. I would want to see this replicated in this extraordinarily low range. You know, we talked about Bradford Hill criteria and consistency of the findings. This is not consistent with other work that admittedly has not gone down below 1 microgram per deciliter.

Q. Okay.

A. My laboratory does not even report blood leads less than 1 --

Q. Okay.

A. -- because of the -- again, you're approaching on the level of detection of the

instrumentation.

Q. Okay. Understand.

So your point, I think, Doctor, is there may well be a threshold below which neurological effects in children do not occur, right?

MR. LANCIOTTI: Object to form.

A. I wouldn't reach that conclusion, Mark, based on this one paper. Again, it's a relatively small sample size; 600 children. They use -- they used an assessment tool that is not one that was used in all of the longitudinal perspective studies. They used this -- it's not the WISC. They use a different test of intelligence. This is referred to as the WPPSI, which can be used in very young children.

The younger you go in assessing intelligence, the more imprecise the measure is. As you might imagine, testing 5-year-olds and 7-year-olds, you can get a better handle on what a child is capable of doing than testing a 3-year-old or a 4-year-old.

Q. Sure. Sure.

It is very difficult, and as you said, it's very imprecise to try to measure IQ at these

early ages, right?

MR. LANCIOTTI: Object to form; foundation.

A. Right.

Q. Okay. And a minute ago, you mentioned the sample size, Doctor, and you mentioned that the sample size here was approximately 600; is that right?

A. That's right.

Q. And as a general matter, you'd agree that the larger the sample size, the more reliable the study, correct?

MR. LANCIOTTI: Object to form.

A. Well, the more statistically powerful. It doesn't mean it's more reliable. There are a lot of things that go into the word "reliable."

Q. Okay. Fair point.

The more statistically powerful -- the more statistically -- the larger the sample size, the more statistically powerful the study is, right?

MR. LANCIOTTI: Object to form.

A. That's right. And I said, the younger the child, the less precise is the measurement of

the outcome.

Q. Sure.

And where does that kick in? Is it a sliding scale, Doctor, as far as the age of the child and the intelligence testing? I get your sense that looking at this study, which was focusing on 3 and -- is it 3- and 4-year-olds -- yes -- that that's a very young age and we should look skeptically at the IQ measurements as being very imprecise; is that fair?

MR. LANCIOTTI: Object to form.

A. The -- you know, the ability to -- just let me look at this one more second.

Yeah, I mean, here again, I'm not the developmental psychologist. My colleague, Gail Wasserman, is the one. And I would -- in a room -- if we were all in the room, I would turn to her and ask her the very question that you asked me. But it's -- it's -- I have no doubt that as one goes into older ages, the ability to assess a child's intelligence gets better and better.

Q. Sure. Okay. It's very imprecise at the younger ages, and then it becomes more precise the

older the child becomes, right?

A. Right.

MR. LANCIOTTI: Object to form.

A. And being imprecise adds -- tends to bias to the null -- to the null finding. If the measurement of the outcome is imprecise, you can have all of the statistical power you want. It still is a bias to the null.

Q. Understand.

And going back to one of your earlier answers, Doctor, I appreciate that you'd like to see this -- the findings of this study confirmed, right?

A. Yes, indeed.

Q. Okay. And if the findings of this study are confirmed, then it may be that they indicate that, in fact, there is a threshold below which exposure to lead does not have an adverse effect on children's neurological function, right?

MR. LANCIOTTI: Object to form; foundation.

A. Possibly.

Q. Okay.

A. Possibly below 1 --

Q. Okay. And sitting here today --
A. -- microgram per deciliter.
Q. I'm sorry. Okay. Have you finished?
A. Possibly below 1 microgram per deciliter.
Q. Okay. And sitting here today, we don't know if there's a threshold or not; is that fair to say? Is that your view?
MR. LANCIOTTI: Object to form; asked and answered.
A. The findings from the pooled analysis, which is the results of seven longitudinal studies from fetal life through age 10 and beyond, indicate that there is no threshold.
Q. Well, you just said I think a minute ago, Doctor, that none of those studies were looking at these very low blood lead levels below 1 microgram per deciliter, right?
A. Agreed. Not below 1, agreed.
Q. And so, again, there may well be a threshold at 1 microgram per deciliter, right?
MR. LANCIOTTI: Object to form; asked and answered.
A. It's conceivable.

Q. Okay. Sitting here today, you don't know; fair to say?

A. Well, I know that the findings from the pooled analysis, I know what they say. This -- looking at this stand-alone paper that has remarkably children with blood leads less than 1, I don't know where you would -- where else you would find such children. But it's -- based on this study standing alone, they would imply that there's a threshold below 1.

Q. Okay. Let's shift to -- back to -- well, your report, Doctor, on Page 11 and a couple other locations, you used the phrase "undue exposure." And to put it in context, you talk about undue exposure as the type that occurred in association with consumption of water from the Flint River.

Do you recall that phrase?

A. I do.

Q. Okay. And what do you mean by "undue exposure"?

A. Essentially that's a term that was used by -- in a report by the CDC back in 1985, the consequences of undue exposure to lead. I believe

it was '85. And it really means any lead exposure that's from anthropomorphic sources, from manmade sources.

Q. Okay.

A. There are natural sources. As I said, volcanos. You have -- you have lead in the air due to natural events. Undue exposure is anything incremental above that.

Q. Got it.

Okay. And so undue would include exposure to lead paint?

A. Yes.

Q. It would include exposure to lead dust?

A. Yes.

Q. It would include exposure to lead in the soil?

A. Yes.

Q. And it would include exposure to any lead that was in the water?

A. Yes.

Q. Okay. All right. And so as you use this phrase, again, as you just answered, you are not referring just to lead in drinking water; fair to say?

MR. LANCIOTTI: Object to form.

A. Well, in the context of my report on the Flint water lead problem, I was, indeed, referring to this undue exposure from lead in drinking water in Flint, which I don't think anyone disputes that that did occur.

MR. TER MOLEN: Okay. Why don't we -- just to make sure there's no confusion, Sam, if you don't mind putting up Page 11 from Dr. Graziano's report, Exhibit 3.

Okay. Yeah, thank you there. If we could go to the second paragraph under 4. And, let's see -- and then it's about halfway down. It's the fifth line down.

BY MR. TER MOLEN:

Q. "Countless studies of dose-response relationships lead to the conclusion there is no safe level of lead." And you say that "And any undue exposure as the type that occurred in association with consumption of water from the Flint River."

Okay? And so in this context in your report, you are talking about exposure to lead in drinking water, right?

A. That is correct.

Q. Okay. And you agree, Doctor, that before the switch in water sources made by the City in April of 2014, that there was lead in some drinking water in homes in Flint, right?

MR. LANCIOTTI: Object to form; foundation; beyond the scope of this expert's testimony.

A. Well, given that it's my understanding that lead pipes were mandated in the 19th century, I would say it's safe to assume that there was some lead in drinking water, yes.

Q. Okay. And based on the studies you've seen, Doctor, you agree that there were some children in Flint who had blood lead levels greater than 5 micrograms per deciliter before the switch in water sources was made in April of 2014?

MR. LANCIOTTI: Objection; form; foundation.

A. Yes, I'm aware of that.

Q. Okay. And you agree that their exposures to lead were, as you used the term, "undue"; is that right?

A. Yes.

MR. LANCIOTTI: Objection; form; foundation.

Q. Okay.

MR. LANCIOTTI: I'm sorry. Was there an answer?

THE WITNESS: Yes.

Q. And sitting here today, Doctor, is it fair to say that you do not have an understanding of what the average level of lead was in drinking water in Flint before the switch in water sources?

MR. LANCIOTTI: Objection; form; beyond the scope of this expert's testimony.

A. That is correct. I do not know.

MR. TER MOLEN: If we can go to Page 3 of your report.

Q. I just would like to make sure I'm understanding what you're saying here, Doctor. You -- in the second paragraph there, you talk about a sequence of poor engineering and policy decisions. I think we talked earlier that in this paragraph and the previous paragraph, you're giving a historical perspective, but you're basically repeating what you read from others, right?

A. That is correct.

Q. Okay. And when you talk here about citizens -- let me start over.

When you talk here about residents of Flint being exposed to lead in their water as a result of the switch, again, you don't know what levels of lead in the water were involved; is that fair to say?

MR. LANCIOTTI: Objection; form; foundation.

A. I only know about the report by Marc Edwards' group. That's what I know.

Q. And that's a report that you cite in your paper where he found that about 20 percent of the 120 homes that he evaluated exceeded EPA MCL?

A. That's correct.

MR. TER MOLEN: We'll put up another document here we'll mark as Exhibit 9, I think. And this is a summary of information of blood lead levels in Flint that comes from the CDC, I believe.

Oh, thanks, Sam. I'm not sure that's the one we're looking for. This is the one that's by Kennedy. I think it's a different document

than this. But if we need to come back, let me know. This is not a new one.

Great. Thank you very much.

- - -

(Graziano Exhibit 9 marked.)

- - -

BY MR. TER MOLEN:

Q. You're familiar, obviously, with the CDC, Doctor, right?

A. Yes, I am, certainly.

Q. And are you familiar with this publication, the MMWR?

A. Yes, I am.

Q. Okay.

MR. TER MOLEN: And if we could scroll down to Page 4 of this document, please, Sam. Thank you.

Q. And this is -- and Table 1 is showing blood lead level tests of children in Flint; is that right?

A. Yes. I have seen this document.

Q. Okay. Good. You've seen that.

And so before the switch, this document shows that approximately 3.1 percent of the

children in Flint had blood lead levels of 5 or more -- 5 micrograms per deciliter or more; is that right?

A. That's right.

Q. Okay. And you agree that those -- that 3.1 percent of children were -- they were exposed to excess lead levels, right?

A. That's right.

MR. LANCIOTTI: Object to form.

A. Yes, that's right.

Q. And then immediately after the switch in water sources in April, the percentage of children with blood lead levels greater than 5 micrograms per deciliter rose to 5 percent, right?

A. That's correct.

Q. And that means that 95 percent of the children in Flint then had blood lead levels below 5 micrograms per deciliter, right?

MR. LANCIOTTI: Object to form; foundation.

A. I agree.

Q. And sitting here today, is it fair to say that for the 95 percent, you don't know to what degree any of those children were exposed to

undue lead levels; is that right?

MR. LANCIOTTI: Object to form.

A. Well, it is common sense -- forgive me -- but if the water supply is carrying, according to Marc Edwards' report, excess amounts of lead, you said yourself that 25 percent exceeded the MCL. Is that -- did I repeat that right?

Q. No. I believe it was 20 percent.

A. 20 percent of the wells tested -- of the sources tested had drinking water above the MCL, then I would argue that at least 20 percent were receiving undue lead from drinking water. They may not have achieved the cutoff point here of 5 micrograms per deciliter, but if they were drinking the water, they were getting undue exposure.

Q. Sure. If they were drinking the water, which is an important qualification, don't you agree, Doctor?

A. Sure. I do.

Q. Okay. And are you aware that with the change in water sources in April of 2014, that there was also a change with the appearance,

taste, smell of the water?

A. Yes, I'm aware.

Q. Okay. And are you aware that that change in appearance, taste, and smell led to a number of Flint residents deciding to stop drinking the water?

MR. LANCIOTTI: Object to form.

A. Just through the press.

Q. It's just through the press that you're aware of that fact, right?

A. Yes.

Q. Okay.

A. Or public reports of some kind or another.

Q. I understand.

And then if you keep looking at the time frame here, after the switch but before the City went back to Detroit water -- so I think it's the third column that we're looking at, moving over from left to right -- then the blood lead levels dropped back down to 3.9 percent of children having 5 or more micrograms per deciliter of lead in their blood, right?

A. That's right. And this, it's my

understanding, is due to the water advisories, of the need to boil water and to avoid the water being provided at the tap.

Q. Would boiling water affect the amount of lead in the water?

MR. LANCIOTTI: Objection to form.

A. It would only concentrate it.

Q. That's what I would expect, yeah.

That would have the opposite effect, right?

A. Right.

Q. Okay.

A. If people were drinking it at all, yeah.

Q. Right. Exactly. Exactly.

Then going to the last column on the right, after the switch back to Detroit water, then there were still 1.4 percent of the children tested had blood lead levels of 5 micrograms per deciliter or more, right?

A. That's right.

Q. Okay. If a child in Flint did not have their blood tested for lead content until February of 2016, can you use that blood lead level to determine whether or not they were

exposed to lead during the time frame that the City was distributing water from the Flint River?

MR. LANCIOTTI: Objection; form and foundation; beyond the scope of the expert's testimony.

A. I would say no.

Q. So let's put that other -- thank you, Doctor.

MR. TER MOLEN: Let's put the other document up, Sam, which is another CDC document, and it's the 2019 document, the Fourth National Report on Human Exposure to Environmental Chemicals.

- - -

(Graziano Exhibit 10 marked.)

- - -

BY MR. TER MOLEN:

Q. Is that a publication that you're familiar with in general, Doctor?

A. Yes. It's not something that I seek out, but, yes, I'm familiar.

Q. I assume it's not bedside reading.

A. No. It's good if you have insomnia.

Q. I'm sure.

MR. TER MOLEN: Okay. If we could -- let's see. Look at -- scroll on down there, and if we can keep going down for, I think, a later time frame.

Q. Okay. Can you describe generally, Doctor, what your understanding of what this document means?

A. Oh, gosh. No. Frankly, it's a compilation of the statistics on blood lead expressed in many manners in children of different ages and different ethnic groups.

Q. Okay.

A. Age groups as well.

Q. And if we -- looking at that category there -- it's near where the cursor is -- you see "age 1 to 5 years, 2015 to 2016"?

A. Yes.

Q. And if you follow that across -- and just some terminology here --

A. Can we enlarge this?

Q. You bet.

A. It's challenging my vision.

Q. And just in terms to make sure I understand, Doctor, the --

MR. TER MOLEN: Whoops. I think we lost the highlighting there, Sam. It should be the -- going up to the 1 to 5 years, 2015, 2016. Yep. There you go. Thank you.

Okay. And if we scroll up a minute there to see the columns -- the headings of the columns.

Q. Okay. And so just the geometric mean, is it fair to call the geometric mean an average, Doctor, or is that something else?

MR. LANCIOTTI: Objection; form; foundation.

A. That's fair.

Q. Okay. And then the 50th percentile column there, that means that 50 percent of the people in whatever the age category is are above and 50 percent are below; is that right?

A. That's right.

Q. And this is looking at the nation as a whole, right?

A. Yes.

MR. LANCIOTTI: Objection; form; foundation.

A. As I recall.

Q. Yes.

So if you look at that line here, 1 to 5 years -- and this is looking at the 2015-2016 time frame -- and the 50th percentile there, the blood lead level shown is .690, right?

A. That's correct.

Q. So that means that -- is it fair if I call that .7?

A. Sure.

Q. And that means that 50 percent of the population had blood lead levels above .7 and 50 percent had levels below that number, right?

A. Right.

Q. Okay. And, again, because this is from the nation as a whole, this is looking at and including areas that have brand-new housing, no lead, et cetera, correct?

A. Correct.

Q. And if we were to look just at, on a national basis, blood lead levels of children who were living in older housing, i.e., before 1990, you would expect to see, for the 50th percentile, a higher blood lead level; is that fair to say?

MR. LANCIOTTI: Objection; foundation.

A. Yes, it is.

Q. Okay. Now, on a hypothetical basis, Doctor -- and obviously we're talking about blood lead levels below 1 and we were looking earlier at the -- several reports in that regard, but if there was -- if -- assuming a hypothetical plaintiff in Flint whose blood lead level was tested at -- in 2015 and found to be 0.7, okay, that would be at, again, the 50th percentile on a national basis, right?

A. Correct.

Q. So they would be right at the national average; fair to say?

MR. LANCIOTTI: Objection; form; foundation.

A. Yes.

Q. And if they were -- and if for this hypothetical Flint plaintiff, a blood lead level of 0.7 would actually be lower than what you would expect to see on an average basis for a child who was growing up in older housing stock such as exists in Flint, right?

MR. LANCIOTTI: Objection; improper hypothetical; beyond the scope of this expert's

report.

A. Depending upon the conditions of the home.

Q. Sure.

And sitting here today, Doctor, would it be your opinion that a child with a blood lead level of 0.7 in 2015 suffered a loss to her intelligence because of that level of lead?

MR. LANCIOTTI: Objection; form; foundation; improper hypothetical.

A. Repeat the question, please, Mark.

Q. Sure.

Is it your opinion, Doctor, that a child who suffered -- let me start over again.

Is it your opinion, Doctor, that a child with a blood lead level in 2015 of 0.7 micrograms per deciliter suffered a loss -- a permanent loss to his or her intelligence because of that level of exposure to lead?

MR. LANCIOTTI: Same objection.

A. Well, I would simply say that a child with that blood lead level wouldn't be perceptibly different than all of the other children in the United States with that blood lead level.

Q. Okay. Fair enough.

So every other child in the U.S., you would expect, would have -- well, I think you phrased it well, Doctor.

This hypothetical plaintiff would be no different than any other child in the United States, right?

MR. LANCIOTTI: Objection; improper hypothetical; and beyond the scope of this expert's report.

You can answer.

A. I already answered the question.

Q. Okay. Well, I think you're agreeing with me. Is that fair to say?

MR. LANCIOTTI: Objection; form.

A. I already answered the question.

Q. Now, you mentioned Marc Edwards.

A. Yes.

Q. Tell me who Marc Edwards is, please.

A. Marc Edwards is a -- I think he's a civil engineer, professor at University of Virginia or somewhere in Virginia. He was previously known -- his name was known to me because of his past work in Washington, D.C. with

an issue regarding lead in drinking water.

And as I read the documents, the commission's reports and so forth, I came to -- I came upon the papers that Marc and his group published about their surveys about water lead concentrations in Flint.

Q. Okay. Have you looked at any of the work that Dr. Edwards did with respect to the City of Flint besides the one study that you cite in your paper on Page 3?

A. I don't believe so.

Q. Okay. Are you familiar with a term called "biosolids"?

A. Yes and no. I can't -- don't ask me for a definition, but the term is familiar to me.

Q. Okay. It is a relatively graphic term, I guess, Doctor.

MR. TER MOLEN: We'll put up a document that we'll mark as Exhibit 11, which is a 2019 study that Dr. Edwards did for -- with respect to the City of Flint related to biosolids.

- - -

(Graziano Exhibit 11 marked.)

- - -

MR. TER MOLEN: If we could blow that up a little bit, I'd like to give Dr. Graziano a chance to read the abstract. Okay?

BY MR. TER MOLEN:

Q. Okay. Is that big enough for you to see, Doctor?

A. Yes.

(Witness reviews document.)

Okay. This is not in my wheelhouse at all, but...

Q. Okay. And if you go about halfway down, do you see that -- let's see, right about that line, starting with the word "months" there, Sam, if you could go over to the right there.

It says "76 percent of the increase in the lead measured in biosolids occurred in July to September of 2014."

Do you see that?

A. Occurred in July to September of 2014, yes.

Q. Okay. And obviously the switch in the water source was done in April of 2014 and is -- at least as I'm understanding what Dr. Edwards is saying in this part of the abstract, he's saying

that 76 percent of increases in the water lead levels that were seen occurred during the time frame in July through September of 2014.

Is that a fair reading?

MR. LANCIOTTI: Objection; form.

A. That's how I read it.

Q. Okay. And do you have any reason to disagree with that conclusion?

MR. LANCIOTTI: Objection; form; foundation.

A. This is just not in my expertise. This is more water -- I don't know if it's chemistry, but water management.

Q. Sure. Okay. I understand.

I'm going to show you another similar paper that Dr. Edwards published earlier this year.

MR. TER MOLEN: And we'll mark that as Exhibit 12.

- - -

(Graziano Exhibit 12 marked.)

- - -

BY MR. TER MOLEN:

Q. Okay. I take it, Doctor, you've not

seen this paper before today; is that right?

A. That's right.

MR. TER MOLEN: If we can go to Figure 1 here, please.

Q. So this Figure 1, Doctor --

THE WITNESS: Could we just pause for 10 seconds? I just have to get a little closer to the screen here.

MR. TER MOLEN: Sure. And we can expand this a bit.

THE WITNESS: Okay.

BY MR. TER MOLEN:

Q. I'm going to focus on the lower of the two graphs here connecting the red dots. Okay?

A. Yep.

Q. So this is showing in graphical form the amount of lead that was measured in the biosolids, basically. Okay?

A. Okay.

Q. And then do you see that there's a real spike there going back to approximately 2011?

A. I do.

Q. Okay. And Dr. Edwards has interpreted that spike to mean that there was a significant

exposure to Flint citizens back in 2011. And I take it you're hearing that today for the first time, right?

MR. STERN: Object to form; foundation; beyond this witness's expertise.

A. Could you repeat it, please, Mark?

Q. Sure.

Doctor, had you heard of the potential for a significant exposure to lead to Flint residents in 2011 before today?

A. No, I had not.

Q. Okay.

A. Not from drinking water, anyway.

Q. Okay. Well, had you heard of a significant exposure in 2011 from any other source?

A. No. Just the historical legacy of the old housing, likely presence of lead paint, which we talked about this morning.

Q. Agreed.

By the way, Doctor, with respect to lead paint, if a home is undergoing rehabilitation and it has lead paint, would that rehabilitation be a potential cause of significant exposure to lead?

MR. STERN: Object to form; foundation; vague as to the term "rehabilitation." Objection as to the speculation associated with any home. Just generally object to the form of the question.

Q. Do you understand the question, Doctor?

A. Yes, I do.

It's certainly known that if lead abatement is done improperly, it can lead to exposure. If done properly, that exposure should be absent.

Q. Okay. So if someone's doing work in their home, they need to properly control for -- let me start over again.

If someone is doing some construction-related work in their home, they need to properly abate the potential for lead exposure to avoid any undue exposures to lead associated with that construction work, right?

MR. STERN: Object to form; foundation. He just testified that if someone was doing lead abatement and they weren't doing the abatement properly, there was a potential for exposure. He did not testify that if someone was doing construction, they needed to do some type of

abatement. You're conflating his answer with your next question, and it's extremely vague and without foundation.

BY MR. TER MOLEN:

Q. Can you answer the question, Doctor?

A. Excuse me.

Homes that have lead paint on the inner wall surfaces can provide a source of lead when the surfaces are perturbed. I think that's as far as I can say here.

Q. Okay. Understand. Understand.

Doctor, what about home demolition? If a home is being demolished and that home has lead paint, is it fair to say that proper abatement measures need to be taken to avoid creating the potential for exposure to lead associated with that demolition work?

MR. STERN: Object to form.

Mark, are you asking him if the home needs to be abated for lead prior to demolition?

MR. TER MOLEN: I think my question speaks for itself.

BY MR. TER MOLEN:

Q. Doctor, do you understand the question?

A. I think so. Are you asking me should a complete teardown of a home be a concern with regard to lead exposure?

Q. Yes, exactly.

MR. STERN: Well, he clearly didn't -- the question didn't speak for itself if he had to ask you about it.

But go ahead and answer, I guess.

A. I would say if a home contains lead and the whole place is going to be obliterated and torn down, then that lead is going to go someplace into the environment and offer an opportunity for exposure.

Q. Very good. Thank you.

You discuss work by Dr. Hanna-Attisha in your report, right?

A. Yes.

Q. Okay.

MR. TER MOLEN: Let's pull that up, and we'll identify that as Exhibit 13.

- - -

(Graziano Exhibit 13 marked.)

- - -

THE WITNESS: I'm familiar with the

paper.

MR. TER MOLEN: Thank you. I understand.

BY MR. TER MOLEN:

Q. In your report on Page 4 -- and if you want me to pull this language up, we can, Doctor, but I'm just going to read it to you. You write that -- bear with me a minute here -- that the work reveals that the incidence of children having blood lead levels greater than 5 micrograms per deciliter, the EPA's level of concern, increase from 2.4 percent before the switch to Flint River water to 4.9 percent after the switch. Neighborhoods with the highest water lead levels suffered a 6.6 percent increase, and that -- well, let me just stop there.

Do you recall writing that in your report?

A. Yes.

Q. Okay. And you're just repeating what Dr. Hanna-Attisha said in her study, right?

A. Exactly.

Q. Okay. And then you added in your report, "No such changes were observed outside the

City of Flint," right?

A. Exactly. Again, quoting her.

Q. Okay. Are you familiar with who Dr. Hanna-Attisha is?

A. Yes, I am. She gave a seminar at Columbia in the department of pediatrics, so I heard her present this, so I've seen her. I can't say I know her.

Q. Fair enough.

You write in your report that the sample size that Dr. Hanna-Attisha looked at had a total of about 1,473 Flint children; is that right?

A. If that's what I said.

Q. Okay. Okay. I'd like to talk a bit about a concept of seasonality with respect to blood lead levels, Doctor.

Are you familiar with that term, seasonality as it relates to blood lead levels?

A. Yes, I am.

Q. Okay. Can you explain to me what it means?

A. Yes. There's a tendency for blood lead concentrations to rise in the summer months that's been known for decades. A long time ago, lead

poisoning used to be called "the summer disease." In fact, there are papers about seasonality. So -- and the mechanism for that is not completely understood.

It's -- there are two hypotheses. One is that it has something to do with Vitamin D, and that when children are outside in the summer, we make Vitamin D from ultraviolet light hitting the skin, and that's how the synthesis of Vitamin D is launched. And Vitamin D has some interactions with lead and maybe it's that mechanism.

Or, alternatively, another hypothesis has been that kids are simply outside more. And this hypothesis was more dominant when we had leaded gasoline and air leads were high. So one line of thought was that it has something to do with kids breathing in contaminated air.

Q. As you're saying, Doctor -- thank you for that -- is you're saying on a national basis, blood lead levels in children are higher in the summer than they are the winter, fair?

A. Yes, fair.

MR. TER MOLEN: We'll introduce our next exhibit here, Number 14, which is a paper by a

gentleman named Laidlaw from 2016.

- - -

(Graziano Exhibit 14 marked.)

- - -

BY MR. TER MOLEN:

Q. As Sam is putting that up, Doctor, let me ask you, have you heard of the name Laidlaw and his paper with respect to Flint?

A. It sounds familiar, but I -- if you show it to me, I'll respond more fully.

Q. We're just going to scroll through quickly to the end, Doctor, but if there is any place you'd like us to stop, let me know.

Okay, Doctor. Just wanted to double-check here again. Have you seen this paper before?

A. I think I have, but --

MR. LANCIOTTI: Do you need more time, Dr. Graziano?

THE WITNESS: Yeah. Give me a chance to read the abstract.

Q. Sure.

A. (Witness reviews document.)

Okay.

Q. Okay. Does that refresh your recollection at all, Doctor?

A. Yes, a bit. Yeah.

Q. Okay. Let me just ask you again. Have you seen this paper before?

A. Yes. I recall seeing it. Not recently, but, yes.

Q. Okay. I don't think I see this cited in your report.

Is it cited in your report?

A. No, it is not.

Q. Okay. Is there a reason you did not cite it in your report?

A. It just is a paper that flew by the screen and went off the radar.

Q. Okay. And by the way you answered that, if you had remembered this report when you were drafting your -- I'm sorry. Let me start over again.

If you had remembered this study when you were drafting your report, would you have cited it in your report?

A. Yes. Likely, yes.

Q. And that's because obviously it's

looking at blood lead levels in Flint, right?

A. Correct.

MR. LANCIOTTI: Object to form.

Q. Okay.

MR. TER MOLEN: Let's go to Page 3.

Q. And this chart, Doctor, I'm looking at in the context of seasonality here, and, again, you see there's an uptick in cases -- again, this is looking at the United States as a whole -- there's basically an uptick in blood lead level concentrations beginning in approximately May?

A. Yes.

Q. Okay. And then that goes through the summer and starts going down, and then by November, it's basically back to where it had been in approximately January?

A. Yes. It's a well-known phenomenon going back decades.

Q. Okay. Now, the City of Flint -- Doctor, just looking at this chart, the City of Flint, as we discussed, began distributing water in April -- the end of April 2015, right?

A. Right.

Q. Yeah. And I'm just speaking -- I'm

sorry -- beginning of April of 2014, right?

A. Yeah.

Q. Right?

And is it fair to say, Doctor, that that time frame corresponds with what you would expect to see as far as a seasonal uptick in blood lead levels?

MR. LANCIOTTI: Objection; form; foundation; vague.

A. Yes, indeed.

Q. Okay. Did Dr. Hanna-Attisha in her study, Doctor -- and we can go back to this if it's helpful -- did they try to control at all in her study for the well-known seasonal increases in blood lead levels?

MR. LANCIOTTI: Objection; form; foundation. He's not the author of that, so...

A. Not that I recall, no.

Q. Okay.

MR. TER MOLEN: Let's go to Page 6 of this report.

Q. Okay. Here -- if you look at this figure, Figure 2 on Page 6 of this Exhibit 14, Doctor, do you see the -- you see, obviously, the

graph that's here?

A. Yes.

Q. And if you look at the bottom, you see that Dr. Laidlaw is charting blood lead levels for the county of Genesee as a whole, right, which includes the city of Flint. Also for the state of Michigan as a whole, and then just for the city of Flint by itself, right?

A. Yes, I do.

Q. And -- whoops -- as you look at the time frame -- and if you see sort of the lower right of this chart, there are those gold arrows going up with the one on the left signaling the start of the Flint River water usage in April of 2014, and the one on the right indicating the City's return to Detroit water in October of 2015, right?

A. Yes.

Q. Okay. And is it fair to say, Doctor, that understanding that the spikes with respect to blood lead levels for Flint are higher than the spikes for Michigan and Genesee County, but that the overall contours, the up and downs of the graph, are the same for Genesee County and the state of Michigan as a whole as compared to the

City of Flint?

MR. LANCIOTTI: Objection; form; foundation; beyond the scope of this expert's report.

A. The contours are the same, but the absolute values in terms of the percent with blood leads greater than 5 are clearly higher in Flint than for Genesee County or for Michigan at large.

Q. Agreed.

Let's go back to the Hanna-Attisha exhibit, which is Exhibit 13.

MR. TER MOLEN: Okay. If we can go to Page 286, please.

Thank you, Sam.

Q. We'll look at this chart, Figure 1 here. In looking at these groups, we've got several different groups that are identified on this chart, right?

A. Yes.

Q. There's -- on the left, it's "Outside Flint," then there's "All Flint," then it's "High Water Lead Level Flint," and then "Lower Water Lead Level Flint," right?

A. Yes.

Q. Okay. And the "All Flint" group, there's an increase there from 2.4 to 4.9 percent, right?

A. Right.

Q. And in the "Outside Flint" group, there's also an increase from 0.7 to 1.2, right?

A. Right.

Q. Now, it's fair to say, isn't it, Doctor, that the group that's outside of Flint is, by definition, not drinking the river water that Flint was providing, right?

A. Right.

MR. LANCIOTTI: Objection to form; foundation.

Q. Nonetheless, the -- that group almost doubled, right? The levels almost doubled for that group, right?

MR. LANCIOTTI: Objection to form.

A. Right.

Q. And do you recall, Doctor, in your report that you were -- you wrote, citing Dr. Hanna-Attisha, that no such changes were observed outside the City of Flint.

Do you recall that?

A. I believe the changes outside were not statistically significant, if I recall correctly.

Q. Okay. So the increase from 0.7 to 1.2 was deemed by somebody to not be statistically significant?

A. As I recall, yes.

Q. Okay. Sitting here today, Doctor, and seeing that we're looking at practically the doubling of the percentage, would you agree that that is not statistically significant?

MR. LANCIOTTI: Object to form.

A. The numbers determine whether it's statistically significant or not, and that is dependent, as we talked earlier, about statistical power; are there enough children with blood lead measurements. So -- and it's -- yeah. So if it's not statistically significant, it's not statistically significant; whereas, within Flint, they are statistically significant.

Q. Okay. So would it be your understanding, Doctor, that there simply wasn't enough information to make a determination as to whether the outside Flint category increased or not in a statistically significant sense?

MR. LANCIOTTI: Objection; asked and answered.

A. Well, the data as presented here indicate -- in this manuscript indicate that there was not a statistically significant change in blood lead levels outside of Flint. I can't speak to that any more than what the data are.

Q. Okay. The -- did Dr. Hanna-Attisha find in her study that all parts of the City of Flint were affected equally in terms of an increase in blood lead levels?

MR. LANCIOTTI: Objection; form; foundation.

A. I think this figure speaks to that question, Mark, that she did not, that there are clearly higher spikes in percentage of children with elevated blood leads in areas that had higher water lead concentrations.

Q. Okay. I think you're absolutely right, Doctor.

MR. TER MOLEN: Let's go to Page 288 here.

Is this 288, Sam? I'm looking for Table 2. Sorry. There we go. Thank you.

Q. And so this table is looking at water lead levels --

A. Could we blow that up? I'm sorry.

Q. You bet. That's just fine, yeah. No need to apologize.

This chart is looking at water lead levels based on different wards in the city, right?

A. Yes.

Q. And based on those water lead levels -- and there's a prediction as to what the blood lead levels will be, right?

A. Just let me digest this for just one moment.

Q. That's fine.

A. (Witness reviews document.)

Could you ask again, please?

Q. Sure.

Based on the water lead levels, this chart then makes a prediction as to what the predicted blood lead levels would be, right?

A. Yes.

Q. Okay. And the water lead levels, when you look at this chart, some of them increased

after the change in water, correct?

A. Which columns are you -- could you point me to --

Q. Sure.

If you look at the -- we've got -- let's see. We've got the water lead level is the second column on the right there, right after the ward, obviously. Okay? And then the comparison here that I'm going to look at is the change in predicted blood lead level from pre to post.

Do you see that, the one on the far right?

A. The far right, yes.

Q. Okay?

A. Yep.

Q. And so as you go ward by ward, some of the blood lead levels are predicted to increase because of a higher water lead level after the switch in water sources, right?

A. Yes.

Q. And, interestingly, some of the blood lead levels are predicted to increase because after the switch in water sources, the water lead levels were lower, right?

MR. LANCIOTTI: Object to form.

A. Yes.

I think you may have misspoke just now.

Q. Okay.

A. Can you repeat that?

Q. Sure. Let me -- instead of bothering Sara here, let me just try to repeat it and make sure I'm speaking correctly.

And in some of the wards, the --

MR. TER MOLEN: Whoops. Sam, I think you're oversharing.

Q. In some of the wards, the blood lead levels are predicted to decrease, right?

A. Yes.

Q. Okay. Indicating that the water lead levels after the switch in water sources were lower than they had been before the switch in water source, right?

MR. LANCIOTTI: Object to form; foundation; beyond the scope of this witness's report.

A. I -- I guess so, yeah.

Q. Yeah?

Okay. All right. And so whether or not

any given Flint resident was exposed to higher levels of lead via the water after the switch versus before the switch would, based on this study, be quite dependent on what ward they lived in within the city, right?

MR. LANCIOTTI: Object to form; foundation.

A. Yes. This is a modeling exercise, right, predicted by ordinary Kriging geostatistical analysis. That is a method that I'm really not familiar with. That's outside my expertise, so I can't be critical about it other than to -- I don't disagree what the numbers say and your opinion. And I agree, that's what the numbers say.

Q. Okay. And then when you were preparing your report, Doctor, did you do any research to determine if there were other scientists who had evaluated the work that Dr. Hanna-Attisha did?

A. I guess the answer is no.

Q. Okay. Sitting here today, are you familiar with a gentleman by the name of Hernan, H-E-R-N-A-N, last name Gomez, G-O-M-E-Z?

A. No.

Q. Okay. Did you look, Doctor, to see if there were other scientists who had also studied blood lead levels in Flint?

A. I believe I did, but I do not know the name Gomez.

Q. Okay.

MR. TER MOLEN: Let's introduce the first Gomez study from 2018, Sam.

- - -

(Graziano Exhibit 15 marked.)

- - -

BY MR. TER MOLEN:

Q. And just to go to the very top here, Doctor, this is from the Journal of Pediatrics, correct?

A. Yes.

Q. Are you familiar with that publication?

A. Yes, sir.

Q. It's a reputable publication?

A. Yes.

Q. Okay. I'll give you a chance to look at this abstract here, Doctor.

A. Yeah.

(Witness reviews document.)

Okay.

MR. TER MOLEN: Okay. Let's go to Page 161.

Q. Okay. In the "Discussion" section here --

MR. TER MOLEN: I'm sorry, Sam. Thank you.

If you go right underneath the "Discussion" section, maybe if you can blow that up a little bit, Sam. Thank you. Okay. Perfect.

Q. And we can go back and look at the charts here in a minute, Doctor, but just to focus on this language, "This investigation demonstrates a substantial decline in both the percentage of blood lead levels greater than or equal to 5.0 and the geometric mean in children of Flint, Michigan from 2006 through 2016."

Okay. Let me just stop there.

The fact that there was an overall decline of blood lead levels of children in Flint, Michigan from 2006 to 2016 would not surprise you in the least, right?

A. Not at all.

MR. LANCIOTTI: Object to form;

foundation.

A. Not at all.

Q. Right?

And you'd expect that given the overall decrease in the amount of lead in the environment, right?

MR. LANCIOTTI: Object to form; foundation.

A. Right.

Q. Okay.

MR. TER MOLEN: And so if we go up and look at the chart here, Sam. I think it's a little bit earlier. Go up a little farther. Yeah, I'm sorry. I may be thinking of the next study.

Why don't we go back down to that language that we were reading.

Q. Okay. And then looking at the pairwise percentage increases, is that phrasing something that you're generally familiar with from your work, Doctor?

A. Pairwise percentage increases? I need a context for that.

Q. Okay. As we look at this chart,

Figure 1 --

MR. TER MOLEN: Thank you, Sam.

Q. -- on Page 160, I'll give you a minute just to look at this, and you can let me know if this is providing good context.

A. (Witness reviews document.)

Okay.

Q. Okay. So this chart is looking at cohorts of children in three different segments, right? Flint, state of Michigan as a whole, and the United States, looking at the percentages of children in each of those populations that have blood lead levels greater than 5 micrograms per deciliter, right?

A. That's right. I'm having difficulty discerning -- oh, I see the color coding now. Okay. Sorry.

Q. That's fine.

A. Yep.

Q. That's fine.

And so when -- just looking at the city of Flint, which is the dark blue bar, obviously, if you look at 2013, for example, on a percentage basis, children in -- there was a lower percentage

of children in Flint with blood lead levels of 5 micrograms per deciliter or more than there was in either the state of Michigan or the United States, right?

A. Right.

Q. Okay. And when you go to 2015 there, then basically the lines converge, right? You've got essentially the percentage of children with blood lead levels in Flint of greater than or equal to 5 micrograms per deciliter is the same as that percentage of children in the United States and also that percentage of children in the state of Michigan; is that fair?

A. That's fair. I'm having difficulty understanding what -- understanding what the asterisk means.

Q. Does it -- we can double-check here. I'm not sure it has any meaning other than it -- there's an asterisk every time there's a number.

A. Oh, it's one for any adjust -- I see. Okay.

Q. Yeah.

A. Got it.

Q. Okay.

MR. TER MOLEN: Thank you, Sam.

Okay. All right. Let's look at the second Flint paper, Sam. We'll mark that as Exhibit 16.

- - -

(Graziano Exhibit 16 marked.)

- - -

BY MR. TER MOLEN:

Q. Okay. This was published in the journal Clinical Toxicology; is that right?

A. Yes.

Q. Are you familiar with that publication?

A. Yes.

Q. Okay. That's a reputable publication?

A. Yes.

MR. TER MOLEN: Sam, why don't you go ahead and scroll through and we'll give Dr. Graziano a chance to take a look at this.

Q. We'll just scroll through and then we'll come back to the abstract, Doctor.

A. (Witness reviews document.)

Q. Let me know, Doctor, when you've had a chance to read that.

A. Yep.

Okay.

Q. Okay. And so in this paper, Dr. Gomez looks at three different 18-month time periods; is that right?

A. Right.

Q. And he's looking to mirror the 18-month time frame from the end of April of 2014 to October in 2015 where the City of Flint was using water from the Flint River as its water source, right?

A. Right.

Q. Okay. And so to that end, he looks at earlier 18-month intervals that cover the same months and then looks at blood lead level data for those time periods, right?

A. That's correct.

Q. Just understanding that, Doctor, is that an appropriate focus of a study, in your view?

MR. LANCIOTTI: Object to form; vague.

A. That's an appropriate approach.

Q. Okay. And Dr. Gomez was looking at both the mean blood lead level and also the percent of children who had blood lead levels of greater than 5 micrograms per deciliter, right?

A. Right.

MR. LANCIOTTI: Object to form.

A. That's right.

Q. Okay. And like Dr. Hanna-Attisha, they looked at all Flint as well as breaking the city of Flint down by ward; is that right?

A. I didn't see the ward data per se, but I -- yeah. I don't disagree.

Q. Okay. Let's look at Figure 1 here.

MR. TER MOLEN: Maybe blow it up just a smidge, Sam. Great.

Q. Doctor, can you see that?

A. Yes, I can.

Q. Okay. And so, again, this is looking at blood lead levels in the City of Flint for children, of course, looking at those three different 18-month intervals, right?

A. Right.

MR. LANCIOTTI: Dr. Graziano, would you want to see the description of Figure 1? I think we have to zoom in a little bit to get that.

THE WITNESS: This figure?

MR. LANCIOTTI: Yeah.

THE WITNESS: I see what it is.

MR. LANCIOTTI: Okay.

THE WITNESS: Yeah.

MR. LANCIOTTI: Thank you, Sam.

A. It's mean blood lead by ward over three time periods.

Q. Okay. So let's look first at the "All Flint" bar, which is the -- kind of the blue bar there, right?

A. Yep.

Q. And back in 2006, the mean blood lead level for children in Flint -- for all of Flint was 2.9 micrograms per deciliter, right?

A. 2.9?

Q. I'm sorry. 2.19.

A. 2.19, yeah.

Q. Okay. Thank you. Appreciate that.

And then we move to the middle group, looking at 2002, which is -- it goes from 2002 to 2013, which was -- the end of that time frame is just a few months before the switchover in water sources, right?

A. Correct.

MR. LANCIOTTI: I think it's 2012, you meant, Mark.

THE WITNESS: Yeah, '12.

MR. TER MOLEN: 2012 to 2013. If I misspoke, I'm sorry.

MR. LANCIOTTI: Right.

BY MR. TER MOLEN:

Q. And then the end of that time frame in October of 2013 is just a few months before the change in water sources, right?

A. Yes.

Q. Okay. And there, the mean for the entire city is 1.47 micrograms per deciliter, right?

A. Right.

Q. Okay. And then going over to the next period, 3, which is looking at the actual time frame when the City was using Flint River water as its water source, the average blood lead level for the entire city was 1.32 micrograms per deciliter, right?

A. Right.

Q. And you see that little -- there's a mark there above the blue bar that's called "OC"?

A. Yes.

Q. Do you know what that means, offhand?

We can look at the legend and break that down here.

A. I don't know what that means.

Q. Okay. We'll come back to that in a minute.

And if you look at -- sticking with Figure 1, Doctor, for each ward in Flint, the mean value reported for period 3, which is the time frame when the City was using Flint River water, is lower than it was for the immediately preceding time period, right?

A. Yes.

Q. Okay.

MR. TER MOLEN: And if we go to the "Discussion" here -- yeah. Thank you very much.

Actually, let's go to Table 2. Sorry.

Q. I'll give you just a minute to look at this table, Doctor. If you are want us to blow this up, just let me know.

A. It's fine. This is fine.

(Witness reviews document.)

Okay. Got it.

Q. And if you look at A here, A is the percentage above 5 micrograms per deciliter,

right?

A. Right.

Q. And that's the exact measure that Dr. Hanna-Attisha used, right?

A. Correct.

Q. Okay. Do -- does this study find a statistically significant difference in the percentage of children that had 5 micrograms per deciliter blood lead levels or higher from period 3, which is the actual crisis time frame, versus period 2, which is the immediately preceding 18 months?

A. No, it does not.

Q. Is it fair to say that Dr. Gomez's findings in this paper conflict with those of Dr. Hanna-Attisha?

MR. LANCIOTTI: Objection; form; foundation.

A. The Hanna-Attisha paper did look at high water lead levels and low water lead levels. And in that regard, it's not exactly the same analysis. I would say that this analysis certainly is not supportive of her paper, but her approach at looking at the geographic distribution

of children with elevated blood leads higher than 5 is a different approach, and one might argue a more targeted approach based on what the water lead concentrations were.

Q. Okay.

MR. TER MOLEN: Let's go to Page 793 if we can, Sam.

MR. MYLER: I'm sorry, Mark. I got some feedback from your mic. What page was that?

MR. TER MOLEN: Sorry. 793.

There we go.

Looking at the start of the "Discussion" section here -- if you don't mind blowing that up a bit. That's good.

BY MR. TER MOLEN:

Q. Okay. Doctor, just to read this first part here, "Contrary to previous investigations focused on examining defined samples of time during the Flint water switch, we found that geometric mean blood lead levels in young Flint children actually decreased during the 18-month water switch period compared to identical previous time periods when controlling for length of time, seasons, and months."

And you agree that that's what the data showed, right?

A. That's correct.

Q. Okay. Sitting here today, do you have any reason to take issue with the findings of this study?

MR. LANCIOTTI: Objection to form; foundation.

A. No. No, I do not. It's, you know, conceivable, given the discussions that we've had throughout the day with the reluctance of residents to drink discolored water and the episodes where water boiling requirements were put out. And as you said, their inclination to drink bottled water rather than to drink tap water, they could contribute to the findings that we've just looked at right now.

Q. Okay. Well, that's an interesting -- interesting hypothesis. Appreciate that.

Now, Doctor, I will tell you that Dr. Hanna-Attisha's study looked at 736 children before the water switch and at 737 children after the water switch. Okay?

A. Yes.

Q. And I will tell you that Dr. Gomez in his study looked at 1,834 children before the switch and 1,734 children after the switch. Okay?

I think Sam's showing you here, if you look under "Demographics."

Do you see that?

A. Yes, I do.

Q. Okay. And I think you testified earlier today, Doctor, that studies with a larger sample size are more statistically powerful, correct?

A. Correct.

MR. TER MOLEN: All right. Why don't we take a break here, if that's okay with everybody else. We're at a good break point for me. Why don't we come back -- maybe a little more than 10 minutes here. Let's plan to be back on at 10 minutes before the hour. Okay?

VIDEOGRAPHER: The time is 2:36 p.m., and we're off the record.

(Recess taken.)

VIDEOGRAPHER: The time is 2:50 p.m., and we're on the record.

BY MR. TER MOLEN:

Q. Doctor, on Page 2 of your report, you

refer to a Needleman paper in 1979. I think we touched base on this a little bit earlier, and you reference that report as -- or that study as being the first study to address what you call low-level lead exposures.

Do you recall that?

A. Yes.

Q. Okay. Sitting here today, Doctor, do you recall what lead level -- let me start over.

Do you recall what blood lead levels were at issue in the Needleman report -- Needleman study, rather, published in 1979?

MR. LANCIOTTI: Objection; foundation.

A. The 1979 Needleman study did not measure blood lead levels. It measured lead in dentine in teeth.

Q. Certainly in part.

MR. TER MOLEN: Why don't we pull up -- we can mark the '79 Needleman study as Exhibit 17.

- - -

(Graziano Exhibit 17 marked.)

- - -

BY MR. TER MOLEN:

Q. And this was published in The New

England Journal of Medicine, right?

A. I've heard of that. Yep.

Q. Exactly.

MR. TER MOLEN: Let's go to Page 4, if we could, of this, Sam. Thanks.

Q. Okay. And bear with me here.

Here we go. In the paragraph right above "Evaluation of Sampling Bias," do you see that they also looked at the mean blood level in 1973 to 1974?

A. Yes.

Q. Okay. Does this refresh your recollection that --

A. Records were obtained in previous -- records were obtained -- so they didn't -- they obtained records, yeah. They didn't actually measure at the time of the two Flint measurements. But, yeah, go ahead.

Q. Okay. You agree, Doctor, that they do have blood lead level results for the cohort that was studied in this paper?

A. So these blood leads were prior blood leads. Yeah, but they are -- they're there, and they are what they were.

Q. Okay. And those range -- for the higher level that was looked at in this paper, it was 35.5 micrograms per deciliter; is that right?

A. That's right.

Q. Okay. And then for the lower group, it was 23.8 micrograms per deciliter?

A. That's right.

Q. Okay. Now, we've talked before, and we'll talk again, about the pooled study, the Lanphear 2005 paper that he rewrote or republished in 2019, Doctor. And it sounded from the comments you made earlier that you view that pooled analysis as establishing that there may be a causal link between lead exposure and effects on intelligence at levels below 5 micrograms per deciliter of blood lead; is that right?

MR. LANCIOTTI: Object to form.

A. That's right.

Q. Okay. Putting that paper aside, Doctor, sitting here today, are you aware of any studies that have looked at and tried to analyze the effects of blood lead levels less than 5 micrograms per liter on the intelligence of children?

A. You pointed out the Canadian paper using the WPPSI in 3- and 4-year-olds.

Q. I did.

A. Yep.

Q. Okay. Other than that paper that we looked at today, anything else that you're aware of?

A. No.

Q. Okay. Now, we talked about Dr. Lanphear, and you indicated you're familiar with him and that you respect his work as an epidemiologist focusing on lead, among other things, right?

A. That's right.

Q. Okay. And Dr. Lanphear has obviously done a number of studies looking at the effects of lead exposure on children's intelligence, right?

A. Yes.

Q. And I'd like to show you portions of a deposition that Dr. Lanphear gave in April of this year. Okay?

A. Yep.

MR. TER MOLEN: We'll mark this as Exhibit 18.

- - -

(Graziano Exhibit 18 marked.)

- - -

MR. TER MOLEN: Thank you, Sam.

Let's go to Page 207.

Okay. Thank you.

BY MR. TER MOLEN:

Q. So if you look at the bottom of 207, Dr. Lanphear is being asked a question that, based on the epidemiological studies, more likely than not, somebody that has blood lead levels that are consistently high will have experienced IQ decrements, or to phrase it in a different way, these plaintiffs would have had higher IQ scores, and she, meaning the plaintiff, might have more scholarships available to her and she might have done better with her GPA.

"Do you recall giving that testimony?"

Answer from Dr. Lanphear, "Yes."

And then a couple of questions. The first question was "First of all, would that statement apply to somebody who does not have consistently high blood lead levels? For example, somebody who might be tested twice and have a

7 microgram per deciliter blood lead level followed by a 15 microgram per deciliter blood lead level?"

And the answer from Dr. Lanphear is, "Well, based on today's standards, those are both quite high."

Would you agree with what Dr. Lanphear said in that first sentence?

MR. LANCIOTTI: Objection; form; foundation.

I don't know what case this is or what context this is being proposed for us here.

But, Dr. Graziano, if you can answer the question, go ahead.

A. I don't agree with Dr. Lanphear's answer.

Q. You do not? Is that --

A. I don't disagree. Sorry.

Q. You don't disagree. Okay.

And then he goes on to say in his answer here, "If you had asked me instead, so I would say generally, it would have still held true. If you asked me whether somebody had a blood lead level of 5 and 4 on points, then I would certainly have

less confidence that those -- that a child with those blood lead levels would have sustained injury."

Do you see that?

A. I do.

Q. Okay. Do you agree with Dr. Lanphear's testimony on that point?

A. Well, the --

MR. LANCIOTTI: Objection; form; foundation.

A. The word "injury" is a bit severe with regard to what one might expect with exposures to low blood levels. And I think, you know, when we talk about loss of IQ points, is that injury? I don't know. It's just -- the word sensitizes me.

Q. Okay. Well, assuming Dr. Lanphear is talking about loss of IQ points here as injury, would you agree with his statement?

MR. LANCIOTTI: Object to form; foundation; improper hypothetical.

A. So let me read it again.

"If you had asked me whether somebody had a blood lead of .5 and 4 on points" -- I'm not sure I understand what that means, "on points."

Q. Well, why don't we assume for purposes of my question, Doctor, that he's talking about 5 micrograms per deciliter and 4 micrograms per deciliter.

A. ".5," he says.

Q. Well, for my question, I'm going to assume he's talking about 5.

A. Okay. Then I would certainly have less confidence that those -- that a child with those blood leads would have sustained injury.

Well, I frankly am surprised by his answer.

Q. Okay. Would you agree with it or disagree with it?

MR. LANCIOTTI: Objection; form and foundation.

A. Here again, I think the pooled analysis and the -- and others have demonstrated levels of concern below blood leads of 5.

Q. Okay.

A. Certainly between 5 and 10.

Q. Okay. So, again, are you disagreeing with what Dr. Lanphear said or not? I just want to make sure I'm clear, Doctor.

MR. LANCIOTTI: Objection; form; foundation; and asked and answered.

A. Again, I don't know what he's -- his use of the word "injury" just troubles me. I don't agree with the term "injury."

MR. TER MOLEN: Okay. Why don't we look at the next page here, Sam. And let's see. If we can go to Page 210 here. Thank you.

Q. This gets into the issue of duration. Okay?

A. Uh-huh.

Q. And we -- you talked about some -- I'll use the phrase "toxicological maximums" a little earlier, right? I think you used the phrase "the dose makes the poison"; is that right?

A. Correct.

Q. And generally for purposes of toxicology, there's the issue of dose on one hand and duration on the other hand, right?

A. That's right.

Q. Okay. And with respect to lead and lead exposure, duration is also important as to whether or not exposure will result in any sort of effect on a child's intelligence, right?

MR. LANCIOTTI: Object to form; vague.

A. That's correct, unless there is an acute severe spike, like an acute poisoning. But for the general population, that's correct.

Q. Okay. So then let's -- looking here on Page 211, Dr. Lanphear is being asked some questions. And we just -- I'm sorry.

MR. TER MOLEN: If you stick up there -- no, go back up there. Yep. Thank you.

MR. MYLER: 210?

Q. And so I guess my question is more temporally, is there a time period that you put on something being sustained as opposed to being more acute?

Do you see that question, Doctor?

A. Just give me --

Q. On the left side there, Line 14.

A. Yep.

Q. And then answer: "Yes. Well, I use the example of a 9-month-old girl who moved into a recently renovated house. Her blood lead level came back at 15. Her mom contacted me. She immediately left the house. Two weeks later, it was down to 2. That clearly is not sustained."

Do you see that?

A. I do.

Q. Okay. Do you agree with Dr. Lanphear's testimony?

MR. LANCIOTTI: Object to form and foundation.

A. Yes. I agree with that. It's -- the half-life of lead in blood is a month, so it's, to me, awfully surprising that it can go from 15 to 2, but if that's what it was, that's what it was. Yeah, I agree.

Q. And then he adds, as you see there starting in Line 22, "When I talk about sustained, it's weeks to months, not days to weeks."

Do you see that?

A. Yeah.

Q. And do you agree with that?

A. I agree with that.

Q. Okay. And when Dr. Lanphear used the term "sustained" here, what he meant was -- and we can look at this on Page 210 -- it was not sufficient -- it was not a sufficient duration of exposure to cause lasting harm.

Is that how you understand it as well?

MR. LANCIOTTI: Object to form and foundation.

A. Yes, I understand it that way.

Q. Okay. Have you ever seen a blood lead level result, Doctor, that came back with a reading of less than 3 micrograms per deciliter?

A. Sure.

Q. Can you explain to me what you would understand that result to mean?

A. I would understand that to mean that the child's blood lead is less than the EPA's level of concern.

Q. Okay. And you mentioned a level of detection earlier in the context, I think, of your own laboratory, and if I recall right, you said your own level of detection is 1 microgram.

A. I misspoke on that. I definitely misspoke on that.

Q. Okay. Okay. Is it lower, in fact, than 1?

A. It's on the order of .1.

Q. I see. Okay. Well, that's fine, Doctor.

Are you aware of some facilities --

MR. TER MOLEN: Rick, I think your mic is on.

MR. BERG: Oh, thank you. Sorry.

MR. TER MOLEN: That's okay.

BY MR. TER MOLEN:

Q. Doctor, are you aware of some laboratory facilities that have a detection limit that is on the order of 3 micrograms per deciliter?

A. That's conceivable. Yeah, that tells me that their technology is old, but, yeah, that's not surprising.

Q. And did you reference a minute ago, Doctor, an EPA standard, if I heard you right, of 3 micrograms per deciliter?

A. No, I did not.

Q. You -- if I --

A. What I was -- I'm sorry. If I said EPA, I meant CDC.

Q. Okay.

A. Yeah.

Q. Isn't the CDC level a Number 5?

A. Yes, it is.

Q. Okay. So just going back again, if a result came back at less than 3, do you have --

sitting here today, do you have any understanding of what 3 would be in relation to?

A. So the Number 5 is simply a -- 5 micrograms per deciliter is a bit of a red flag that public health officials should go and try to seek out the source of exposure because the child is not behaving -- is not in the typical range of blood leads. So it's a mark in the sand that we should be concerned that there's a source that may be preventable.

Q. And that's the Number 5, right?

A. Yes.

Q. Okay. And so, again, I'm just going to go back to the Number 3.

Are you aware of any reason to focus on the Number 3?

A. No.

Q. Okay. We talked earlier -- you talked earlier, Doctor -- let me ask a different question.

If you're looking at a single blood lead level result, Doctor -- and let's say it is this, less than 3 micrograms per deciliter. Okay?

A. Yep.

Q. If you're looking at that in itself in isolation, is that enough information to tell you that a child has been exposed to concerning quantities of lead?

MR. LANCIOTTI: Object to form; foundation; improper hypothetical.

A. In and of itself, no.

Q. Okay. Isn't it fair to say, Doctor, that you would really need to have at least two different blood lead level results separated in time to establish a level -- both a level of exposure, a dose, and a duration to make any potential conclusions as to whether or not, in fact, damage had occurred from lead exposure?

MR. LANCIOTTI: Object to form and foundation; improper hypothetical.

A. ... a single point in time leaves you uncertain about the duration of exposure. It could have been higher before the measurement was taken, and it may well be just a single aberrant blip.

Q. Right. The earlier part of your answer may have gotten cut off. I don't know.

MR. TER MOLEN: Sara, did you have some

interference on your end?

THE STENOGRAPHER: Yes, I did.

MR. TER MOLEN: Yeah? Okay.

Q. I'm just going to ask you, Doctor, if you don't mind just to repeat your answer.

MR. TER MOLEN: Or Sara, if you don't mind reading back the question and then we can go there.

I'm sorry, Doctor. There was some interference when you started speaking, and we just lost the first part of your answer.

THE WITNESS: Sure.

(Record read back as requested.)

MR. LANCIOTTI: Same objection.

A. And my -- excuse me.

My answer is that, yes, you would really like to have two points in time because that single blood lead level of 3 might actually be -- may have been higher earlier. You can't know. Or it may actually be the peak, not knowing. So you really would like to have additional information.

I've seen plenty of children back in their days when New York City, when we were doing our clinical trials, where you come to realize

when by the time the child came to our clinic, we had a blood lead measurement that was actually on the decline. Prior to arriving at our clinic, the child had had much higher.

So you can't tell which way it's going and how long the duration is.

Q. Sure. Understand.

On Page 5 of your report, Doctor, and, again, I can show this if you want to, but you write that the steepest decline in IQ function occurs in the very low blood lead range.

Do you recall that?

A. I do.

Q. And what do you mean when you use the phrase "very low blood lead range," if you can explain, please.

A. Well, I think the dose-response relationship, if you look at -- if I had a piece of paper, but if you look on the Y axis, plot blood lead from zero to 50, and on the -- I'm sorry. On the X axis, plot blood lead from zero to 50, and on the Y axis, child IQ, virtually all, as I recall, of the seven prospective studies see a very steep decline in the low blood lead range,

10 or 15 and less, and then a flattening of the curve as the blood lead goes above 15 or so. By that, I don't mean a single point measurement of a single blood lead, but typically an average blood lead over a period of the longitudinal study of the child.

Q. Sure.

And, Doctor, obviously we looked earlier today at a Canadian paper you were seeing for the first time, right, that was looking at blood lead levels below 1 and indicating that there was no correlation there with lead exposure and any measurable IQ loss, right?

A. At age 3, right.

Q. At age 3, yeah.

And so that would -- and, Doctor, sitting here today, do you know, going back to the pooled study that you were talking about, how many -- of the subjects collectively that were looked at in the seven different cohorts that were included in the pooled study, how many of those had blood lead levels below 7.5 micrograms per deciliter?

MR. LANCIOTTI: Objection; foundation.

A. Without looking at the paper or the data, I can't recall that.

Q. What's the -- do you recall approximately, Doctor, the overall number of subjects who were included in that pooled analysis?

MR. LANCIOTTI: Objection; foundation.

A. I think I have a note.

1333.

Q. Okay. And, Doctor, if I told you that only 103 of those had blood lead levels below 7.5 micrograms per deciliter, would that surprise you?

MR. LANCIOTTI: Objection; form; foundation.

A. No.

Q. Okay. Well, isn't it fair to say, Doctor, that it's -- a pool of 103 is a pretty small pool to make conclusions with respect to effects below 7.5 micrograms per deciliter?

A. But the construction --

MR. LANCIOTTI: Sorry.

Object to form; foundation.

Go ahead, Doctor.

A. The construction of that dose-response curve does not ignore all of the children above 7.5. The construction of the curve is powerful because we have a wide range, and that's -- that's the nature of the pooled analysis.

Q. Well, I understand that you're -- in your view, the curve, as you call it here, has a number of data points, well over a thousand data points, it sounds like, as you go above 7.5 micrograms per deciliter. But as you get below 7.5 micrograms per deciliter, it gets pretty sparse because we're talking only 103.

MR. LANCIOTTI: Objection; form; foundation.

A. I don't disagree, but the statistical modelers who have spent careers trying to fit curvilinear functions to a dataset like this have convinced me that they are able, with great confidence, to construct a curve. You can't just look at a tiny window of the curve. You look at the entire range of the curve.

Q. Well, I appreciate that. And I appreciate that statisticians can accomplish many things. And I'm often reminded of the Mark Twain

quote, right, that there's lies -- damn lies and statistics, right?

So -- but as you look at the actual -- you would agree, Doctor, would you not, that statistics has to take a second chair to actual results, right?

MR. LANCIOTTI: Objection to form.

A. Well, statistical analysis is part of the means by we get to actual results.

Q. I understand. And I agree with that, Doctor. The -- and I think we're actually all saying -- or you and I are saying the same thing here, that when you talk about the curve and you talk about -- and you look at projecting that down below 7.5, it really is -- it's a projection, right?

MR. STERN: Objection; form; move to strike the colloquy. There's only one individual testifying today, so there should be no agreement about anything insofar as there's only one person testifying.

A. Can you restate your question, Mark?

Q. Sure.

As the curve, as you call it, gets below

7.5 micrograms per deciliter, Doctor, you agree it's a -- it's a projection?

A. It's a statistical representation of all of the data, including the data above 7.5 and the data below 7.5.

Q. Okay. And to take your phrase, Doctor, the steepest decline in IQ function occurs in the very low blood lead range.

Does that effectively mean that the initial exposure causes the most damage?

MR. LANCIOTTI: Objection; form.

A. No. You are referring to temporal issues, Mark. You know, these longitudinal cohorts have very good repeated measurements of blood lead in children again and again. Our study, we measured blood lead every six months from the umbilical cord blood lead measurement at 6, 12, 18, 24, so on, measurements.

And so when we're talking about a number -- a blood lead number, it's not at a single point in time. It's often an integrated average over a block of time over some duration.

Q. Thank you. I appreciate that, Doctor. Why don't we go at this with some hypotheticals.

That might make it a little easier here. Okay?

So let's hypothetically assume that we have a child age 4 who has a blood lead level of 2 micrograms per deciliter, and that -- and she's tested three times over six months and consistently has a blood lead level of 2. Okay?

A. Yeah.

Q. And is it your testimony that a blood lead level of 2 micrograms per deciliter would cause lasting harm to the child's intellectual functioning?

MR. STERN: Object to form; foundation.

Are you asking him in that moment that a child with a lead level of 2, or a child who has a lead level of 2 today but previously had a lead level of 4; and 30 days earlier, 8; and 30 days earlier, 16; and 30 days earlier, 32; and 30 days earlier, 64?

MR. TER MOLEN: I'm asking the question I asked.

Q. Can you answer that question, Doctor?

A. I'm sorry. I'm going to ask you to repeat the question.

Q. Sure.

MR. TER MOLEN: Sara, do you mind reading it back?

(Record read as requested.)

A. It's conceivable that it could cause a very, very small loss in the child's intellectual capacity, but not much at all.

Q. Okay. Okay. Let's look at Page 6 of your report, Doctor. There you write, in part, that the molecular and physiological effects of lead are well understood.

Do you recall that?

A. Yes, I do.

Q. Okay. And is that a recent development, Doctor?

A. No. It goes back at least 20 -- 20 years or more.

Q. Okay. And you cite a paper by a gentleman by the name of Klassen published in 2018, if I'm pronouncing that correctly.

A. Yeah. Kurt Klassen. That's actually a textbook. I refer to a chapter in a textbook that talks about molecular mechanisms.

Q. Okay. And you cite the Klassen text as discussing numerous mechanisms, I think, to use

your phrasing, that are involved in altering brain function from lead exposure; is that right?

A. That's right.

Q. Okay. Can you -- are you able, sitting here today, to describe to us what those mechanisms are?

A. To some extent, sure.

So -- and this work is largely derived from animal models because you can't get inside of a person's brain and look.

But lead interferes with many neurotransmitter functions, the dopaminergic neurotransmitters, the cholinergic neurotransmitters. And it mimics calcium in the brain. There's a group at Johns Hopkins back in time who studied protein kinase C, which is a calcium dependent, critically important enzyme in brain development and functioning. And their review article -- I just looked at it not -- their review article has been cited -- this is -- oh, Goldstein is one of the authors, but it's been cited 800 or 900 times as others in the field move forward and look at molecular mechanisms.

Q. Okay.

A. I believe to some extent it interferes with the reuptake of neurotransmitters at the synapse.

Q. Okay. Does Klassen's text support a claim, Doctor, that there is no threshold for effects of lead on brain function?

A. No, because this is all animal-modeled work.

Q. Okay. And similarly, is it fair to say that the Klassen text does not support a claim that the effect of lead is greater at lower doses of exposure than at higher doses of exposure?

A. Not that I recall.

Q. Okay.

A. I mean, this was an examination of molecular mechanisms. I don't recall exactly.

Q. Fair enough.

Are you familiar, Doctor, with different EPA action levels for lead in the water?

A. Going back in time, you mean? The evolution of the MCLs, you mean?

Q. No. Thank you. I'm sure that would be a fascinating discussion, but maybe just focus currently, what the MCLs are currently, Doctor,

for lead.

A. The MCL is 15 micrograms per deciliter.

Q. Okay. And is that an action level?

A. So I'm trying to remember the Lead and Copper Rule and what the implications are of having a water lead above 15, and I can't remember exactly what the actions are. But attention is brought to the matter.

Q. Okay. And, Doctor, is it -- well, are you able to convert consumption of -- are you able to convert a water lead level, if you will, into a blood lead level?

MR. LANCIOTTI: Objection; form; foundation.

A. One can estimate the ingested dose. We use the norms of how much water a child of that age or an adult of that age typically drinks. And there are, you know, established values that we assume a child would drink. I used to know it, but I don't.

Q. That's okay.

Is there a model out there, do you know, that's sanctioned by EPA? Is it called IUBKE, something like that?

A. IEUBK, yes.

Q. Well, I was close. Thanks.

Okay. And is that a model that does what you're describing, which converts, essentially, water lead levels into blood lead levels?

A. The IEUBK model can incorporate water lead concentrations in the prediction of blood lead concentrations in children. It's essentially based -- the model is based on communities in which -- that have been studied extensively where they know the soil lead concentration, they know the air lead concentration, they know the dust lead concentration, they know the water lead concentration. And when all put together, if you take those values for a community and plug them into the model, you can actually predict what the frequency distribution of blood lead in children will look like.

I served on a National Research Council committee some years ago. Perhaps this is too long of a story, but the IEUBK model was challenged by the senators from Idaho. It was the Coeur d'Alene, Idaho Superfund site. And there

had been a Superfund site in the so-called Silver Valley of Idaho, in the panhandle, that 25-square-mile site was cleaned up over a period of 20 years.

During that process, EPA came to learn that lead tailings from the mine had moved down the river toward the Coeur d'Alene River. And EPA declared the entire length of the Coeur d'Alene River to be another Superfund site, at which point the two senators went nuts because they had just rebuilt that area to become tourist -- tourism was a big part of the economy.

And so the senators got the national academy to convene a committee. And actually, they were challenging EPA on this very model, on the IEUBK. And to make a long story short, the committee, which was a very distinguished committee, actually came to conclude that that model was a very useful model in predicting the distribution of blood leads in children.

Q. Thank you. I appreciate hearing that.

The -- would you agree that the MCLs issued by the government are meant to be protective?

A. Yes.

MR. LANCIOTTI: Object to form.

Q. And sitting here today, do you know if somebody was drinking water that had 14 parts per billion of lead in it, what that would translate into as far as their blood lead?

A. I do not.

MR. LANCIOTTI: Object to form.

A. I cannot.

Q. And, Doctor, are you aware that the FDA regulates the lead content of bottled water?

A. Yes.

Q. Okay. And, similarly, is that regulation intended to be protective, in your view?

A. I would certainly hope so.

Q. Do you know what that level is?

A. I do not offhand. I did, but I don't.

Q. Okay. If I told you 5 parts per billion, would you accept that?

A. Sure. Sounds reasonable.

Q. Okay. And sitting here today, do you have any opinions as to whether or not drinking bottled water with 5 parts per billion of lead is

safe?

MR. LANCIOTTI: Object to form.

A. I have not specifically considered that.

Q. Okay. Fair to say that you drink bottled water without worrying about that; is that right?

MR. LANCIOTTI: Object to form; foundation.

A. I don't, but I would. Yep.

I'll give you a factoid, Mark.

Q. Please.

A. The amount of energy that is used to create a bottle of water is equivalent to a third of a bottle of oil.

Q. Really?

A. Yes. When one considers the amount of energy to obtain the water, make the plastic, transport the bottle and so on. So it should be a deterrent to all of us to not drink bottled water.

Q. Well, I've got to use my thermos more often; that's for sure.

A. And using -- going back to your Mark Twain, you reminded me of Harry Truman, who always wanted a one-handed economist, because he

said the economist, "On the one hand, and on the other hand..."

Q. We looked earlier at a document, Doctor, that was the -- oh, let's see. It was the -- I want to say it was the 2019, or maybe it was a 2016 -- it was one of the CDC summaries looking at blood lead levels, and we were looking at national blood lead levels. And you recall that we looked at the 50th percentile?

A. .7, yes.

Q. Yes, right. Good memory.

Would you call .7 a low blood lead level or is that sort of a super low blood lead level, if you will?

MR. LANCIOTTI: Objection; form.

A. Well, I'm an old-timer, you know. In historical context, it's a very low blood lead concentration.

Q. Yeah.

And obviously you cited the Needleman paper in '79 that we looked at earlier that was looking at, quote, unquote, low blood levels, but as we looked at in that paper, the blood lead levels, in fact, were in the 23 to 35 micrograms

per deciliter range, right?

A. Back in the lead gasoline year.

Q. Yeah, back in -- just before -- well, just at the end of that era, I guess, right? Just the end of the '70s.

MR. TER MOLEN: Okay. Now, I'd like to look at a couple of documents here. This will be Exhibit 19.

And it's a 2019 report from -- it might be the Michigan Department of Public Health, but we'll see that in a minute here, looking at blood lead levels at different parts in the state of Michigan. Okay?

- - -

(Graziano Exhibit 19 marked.)

- - -

BY MR. TER MOLEN:

Q. Okay. Department of Health and Human Services. Close.

MR. TER MOLEN: Thank you, Sam.

Q. Have you seen this document before, Doctor?

A. No, I have not.

Q. Okay.

MR. TER MOLEN: If we could turn to Page 7. I think it's -- is that Page 7, Sam? Sorry. Here we go.

Q. So this is a chart --

MR. TER MOLEN: If you can blow that up a smidge. Thank you.

Q. -- a chart that's looking at blood lead level results by county.

Do you see that?

A. Yes.

Q. And if you look at the last column all the way in the right, that identifies the number of children in that county who were tested -- and this is, again, focusing on 2014 -- for lead and had blood lead level results -- the percentage that had blood lead level results higher than 5.0 micrograms per deciliter, right?

THE WITNESS: Could I stop us right here? I would like one minute to put drops in my eyes, because --

MR. TER MOLEN: Doctor, why don't we just -- thank you. That's just fine. We'll take a break. Why don't we come back at a quarter to the hour. Okay? Just give you a bit more time.

THE WITNESS: Thank you very much.

VIDEOGRAPHER: The time is 3:35 p.m., and we're off the record.

(Recess taken.)

VIDEOGRAPHER: The time is 3:45 p.m., and we're on the record.

BY MR. TER MOLEN:

Q. Okay. Terrific. I think we were looking at the exhibit we marked as Number 19, which was a chart with some small numbers that I think drove you to eye drops.

A. That's right.

Q. And I think I'd asked you, Doctor, if you would confirm that the column to the far right there is identifying the percentage of children in any particular county within the state of Michigan who have a blood lead level of 5 micrograms per deciliter or more, right?

A. Just -- just give me one moment, please.

(Witness reviews document.)

You're referring to the very far right?

I see, percent BLL greater than 5. Yep.

Q. Okay. And if we scroll down here -- we'll look for Genesee County.

And you understand, Doctor, that Genesee County is the county in which the City of Flint is located?

A. I do.

Q. Great.

Okay. You see Genesee there is at 2.6 percent?

A. Yes, sir.

Q. Okay. And then just looking down that same page, you see "Jackson," a little bit farther down?

A. I do.

Q. Okay. And Jackson, obviously, is much higher at 5.6 percent, right?

A. Right.

MR. LANCIOTTI: Objection; form.

MR. TER MOLEN: Okay. And if we go to the next page there -- I'm sorry. The next page. Thank you, Sam. Keep scrolling down. There we go. Oh, scroll up a little bit. We'll start with the L's. We'll still be with the L's. Look for "Lenawee." There we go.

Q. You see Lenawee County there? It's 10.2 percent?

A. I do.

Q. And then if we go down to Mason, you see, is 6.5, and then we've got a couple other high ones right there -- or higher ones. Menominee, 6.1; Muskegon, also 6.1.

Do you see those?

A. I do.

Q. Okay. And they separately list out Detroit.

MR. TER MOLEN: And if we can see -- if we can keep going down, I think we'll see Detroit, Sam.

A. I see it.

MR. TER MOLEN: Right there.

Q. Okay. And you see Detroit is 8.2?

A. Yes.

Q. Which is -- oh, gosh, that's almost three times higher than the -- than Genesee County, right?

A. Right.

MR. LANCIOTTI: Object to form.

A. Right.

Q. Okay.

MR. TER MOLEN: And if you go to Page 11

here, Sam. Thank you.

Q. This is talking about cities that received specific funding for lead prevention. So this looks at -- this includes Flint, which is breaking Flint up from Genesee County, and you see Flint is higher than the county as a whole, right?

A. Yes.

Q. At 4.5, and that's just a little bit less than half of what Detroit is, right, at 8.2?

A. Right.

Q. And then you see the other cities here. Highland Park is, obviously, much higher at 15.9, right?

A. Right.

Q. I'll introduce the next exhibit, Exhibit 20. And this is going to be the same kind of information, Doctor, but for the subsequent year, 2015. Okay?

A. Okay.

- - -

(Graziano Exhibit 20 marked.)

- - -

MR. TER MOLEN: Let's go to Page 19 here.

And if we can scroll down again to Genesee County.

BY MR. TER MOLEN:

Q. And you see Genesee is 2.3?

A. Yes.

Q. So they actually declined a bit over the previous year, correct?

A. I don't recall what the sample size was in the previous year, but, yes. For what it's worth, yes.

Q. Okay. And then once again, we can scroll through this.

MR. TER MOLEN: If you go to the next page and look at Lenawee -- there we go --

Q. It's -- down there it's 10.

MR. TER MOLEN: A little bit higher up.

Q. The county of Kent, you see that, is 6.2?

MR. TER MOLEN: And if we go to Page 22.

Q. Again, the City of Detroit is identified separately here, and that's at -- 7.5 percent of the children in Detroit had blood lead levels of 5 micrograms per deciliter or higher, right?

A. Right.

Q. Okay. And, Doctor, would you expect, just focusing on the children in the City of Detroit, if a child -- well, you know what? We'll leave that alone.

We'll get to one of the moments we've been building up to, Doctor, which is the Lanphear 2005 study.

Now, you mentioned that report -- you mention that study in your report, obviously. We've talked about it a number of times today. And he published that pooled study in -- initially in 2005, right?

A. That's correct.

Q. And he republished it in 2019, correct?

A. That's correct.

Q. And the reason he republished it in 2019 was to address some errors identified by another scientist by the name of Crump, C-R-U-M-P; is that right?

A. That's right.

Q. Okay. You were a coauthor of the 2005 study, right?

A. And the second study, yeah.

Q. Okay. Well, that's what I was going to

ask you.

So you were also a coauthor of the second study, right?

A. That's correct.

Q. And so when you say in your report that you were careful not to cite your own work, obviously this is an exception to that, right?

A. Yes. Okay. That was a slip.

Q. Okay.

MR. TER MOLEN: Why don't we put in the 2005 study. We'll mark that as Exhibit 21.

- - -

(Graziano Exhibit 21 marked.)

- - -

MR. TER MOLEN: And let's look at the abstract, Sam, if we can.

Thank you.

A. Okay.

Q. So reading about halfway down here, Doctor -- let's see -- it would be 12 lines from the bottom here. There's a sentence that starts "Using a log-linear model, we found a 6.9 IQ-point decrement associated with an increase in concurrent blood lead levels from 2.4 to

30 micrograms per deciliter," right?

A. Right.

Q. And so just to restate that in more layman's terms, when the blood lead level of a particular child increased from 2.4 to 30, you found a loss of IQ points of almost 7. 7 IQ points; is that right?

A. Yes.

MR. LANCIOTTI: Object to form.

A. In -- in populations of children, if you compare those with 2.4 to a 30, the mean drop in IQ was 6.9.

But, if we go on, much of that decrement in IQ happens on the lower end of that range of 2.4 to 30.

Q. Okay. Thank you. I do see that.

And so the increase from 2.4 to 10, which is, what, 7.6, the increase from 10 to 20, which is 10, and the increase from 20 to 30, those increases were respectively -- or the loss of IQ points associated with those increases was respectively 3.9, 1.9, and 1.1; is that right?

A. That's right. So it's in that lowest range of 2.4 to 10, that much of the segment, that

the damage was done.

Q. Okay. And just to be clear, the study here focuses on -- with the lowest level I see identified here for purposes of looking at losses in IQ points is 2.4 micrograms per deciliter, right?

MR. LANCIOTTI: Objection; form; foundation.

A. That's not the lowest blood lead of any child. That's just -- you know, this is just a means of trying to make a very complicated issue interpretable to the reader. I don't know if that's useful, but, you know, any reviewer will say, well, put it in -- put the result in terms that anybody can understand. We're not talking about a child with a 2.4 and a child with a 10. But if you model the dose-response curve, as the statisticians did, this is what the model shows.

Q. Sure.

And I appreciate, Doctor, that we're talking at a population level and not an individual level, right?

A. Yeah. Right.

Q. Okay. I appreciate you're not looking

at any individual child and indicating what IQ loss they may or may not have, which is, I think in part, what you're saying, right?

A. That's right.

Q. Okay. And obviously as we discussed earlier, there's a large number of other factors that can come into play.

But the question I'm getting at, Doctor, is understanding this study is at a population level, that the focus of the study, the lower level of blood lead that was looked at in the study was 2.4, right? And then that went on up from there, correct?

A. No. That's not --

MR. LANCIOTTI: Objection; form; foundation.

A. That's not correct.

Q. Okay. Why is it not correct? Because I'm looking in here -- and I appreciate this is the abstract. If there's more in the text, we can -- you can direct me there as the coauthor here.

But, again, the abstract, as I'm reading it, as we read it together, is using 2.4 at the

lower level and going up from there, right?

A. Yes. And that's -- that's for illustrative purposes. It's not as though we didn't look at blood leads lower than that, or that the model didn't create a curve that went below that. I'm sure you'll eventually get to the figures in the paper, which may be more helpful.

Q. Okay. Well, I understand that the model may have created a curve, but where -- can you show me -- and we can scroll through here -- can you show me where in the paper it purportedly studies IQ decrements below 2.4 micrograms per deciliter?

A. I think we need to look at the figures.

Q. Okay.

A. So here we have descriptive data for Boston, Cincinnati, Cleveland, Mexico, Australia, Rochester, Yugoslavia.

But I'd like to go to the graphics. I don't know which figure number it is.

Okay. So these -- these models -- and they are models -- look at the one, Figure 3 here. It depicts a model that creates the dose-response curve IQ versus, for example, concurrent blood

lead across a range that goes down well below 2.4. And I think the surprise to all of us -- not a total surprise, because individual studies had seen this relatively steep drop-off in the range below 10, but we looked at this in different ways. Concurrent blood lead, if you scroll down a little bit. In Figure 4, modeling it, looking at those with peak blood leads higher than 10, the solid line, and less than 10, importantly, that fine dotted line, that's where the model shows the steepness of the curve for blood leads lower than 10. And it does go down -- all the way down to, you know, very small numbers.

Q. Okay. Anything else you want to show me, Doctor, that illustrates -- besides these models, that illustrates where this study purports to study blood lead levels below 2.4 micrograms per deciliter?

A. No.

Q. Okay. So going back to the abstract, Doctor, why did -- why did you as an author here choose 2.4 as the starting point?

MR. LANCIOTTI: Objection; form; asked and answered.

A. Honestly, I don't recall.

Q. Okay. Then has anybody re-examined the data that was collected in this study and reached a different conclusion regarding the relationship between low-level lead exposure and health effects?

A. The EPA conducted a reanalysis of this same data, and EPA concluded -- in fact, this occurred after the reanalysis, you know. So there was an error here. The Boston group, the Harvard group, when they submitted their data to Dr. Lanphear, whoever sent the data over didn't send full-scale IQ. They -- so IQ scores have subscales, performance IQ and verbal IQ. And they inadvertently sent the performance IQ rather than the full IQ, which encompasses performance and verbal.

So the analysis was redone. And after it was redone, the result of the subsequent publication really reiterated essentially the same findings. The numbers were tweaked by a tiny bit. But EPA then reanalyzed that corrected dataset and concluded that the errors did not change the overall results or the scientific validity or the

conclusions.

Q. Okay. Well --

A. And I'm essentially quoting from the EPA document.

Q. Okay. Appreciate that.

MR. TER MOLEN: Let's introduce the next exhibit, which will be Exhibit 22. And this will be the 2013 study by Crump that was analyzing this 2005 study that's Exhibit 21.

- - -

(Graziano Exhibit 22 marked.)

- - -

BY MR. TER MOLEN:

Q. Okay. You've seen this document before, right, Doctor?

A. Yes, I have.

Q. Okay. And you cite to the Crump study, I believe, in Page 5 of your report in this case, right?

A. I believe so.

Q. Okay. You don't engage in any discussion of what the Crump study says, though, correct?

A. Not to any extent, no.

Q. Okay.

MR. TER MOLEN: Let's go to Page 793 of this, Sam.

Q. Okay. There's some highlighted language there. And starting at the beginning of the paragraph, Doctor, in which the highlighted language is, it says that "the confidence intervals on the coefficients plotted in Figure 3" -- we'll go back to Figure 3 in a minute -- "naturally get progressively larger for progressively lower blood lead levels owing to the fact that each subsequent point is based upon fewer children."

A. Exactly.

Q. Pardon?

A. Exactly. Yep.

Q. And then it says "Below peak blood lead levels of around 4 to 6 micrograms per deciliter, the confidence intervals become so wide that they provide essentially no information."

Did I read that correctly?

A. Yes, you did.

Q. Okay. And by saying that "the confidence intervals become so wide that they

provide essentially no information," is it fair to say that what Crump is saying is that once you get below 4 to 6 micrograms per deciliter, there's insufficient data to determine whether or not there is any harm?

MR. LANCIOTTI: Objection; form; foundation.

A. Well, this is their opinion. This is their opinion, and it is without question that the confidence intervals become wider as you go lower and lower. These are -- these authors are hired -- you know, it's a consulting firm, and they reached this opinion. Even Sir Bradford Hill, if one reads his original -- what was a lecture and became a paper -- argues strongly at the end of his lecture, his paper, that one should not rely religiously on statistical significance and that one needs to look at the whole set of criteria that we talked about earlier.

And so they can come down on this side of their conclusion. I can't dispute it. But it is -- at that point in time, it's a matter of opinion. Here again, because there's so much

confidence in the data just above the 4 to 6 and the modeling brings it into the shape that it is, you know, I'll give them their opinion -- I'm entitled to mine -- but it gets down to that, basically.

Q. Okay. I think I understand. Thank you, Doctor.

And just to restate what I think I heard you say is that when you get down to the levels of 4 to 6 micrograms per deciliter of blood lead, that Crump wrote that the data is not sufficient to identify any harm?

MR. LANCIOTTI: Objection; asked and answered; mischaracterizes the witness's testimony.

A. That is mischaracterizing what I said, yep.

Q. Okay.

A. You know, we're taught always to look at the source of funding for scientific publications. You know, our work was funded by the National Institutes of Health. This work, it's a consulting firm. I don't know who funded them to do this, to try to attack. They did a reasonable

job of reanalyzing the data and recreating the same dose-response curve. Their interpretation at the low end of the curve is different than mine.

Q. Okay. So as I think you said, it's a matter of interpretation, right?

A. Yes.

Q. Okay. And then later in that same paragraph, Crump writes, "however" -- and I'm just -- here we go -- yeah. I'm sure we're on Page 798.

Okay. So starting in this paragraph here --

MR. TER MOLEN: Thank you, Sam.

Q. -- Lanphear, et al. stated that they found no evidence but threshold exposure below which blood lead levels has no association with IQ.

And we've talked about that some today, right, Doctor?

A. Yes.

Q. Okay. And the next sentence is "There appears to be nothing in our analysis to challenge this conclusion."

A. Good.

Q. And then he says "However, the question of whether or not a threshold of exposure exists can never be answered definitively by a statistical analysis."

Did I read that correctly?

A. And he refers to his own work, which I'm not familiar with, the Crump 2011.

Q. Okay. But I read that correctly, right?

A. Yes.

Q. Do you agree with that?

MR. LANCIOTTI: Objection; form.

A. I'm not a statistician. This is beyond my pay grade in terms of the statistical analysis.

Q. Okay. And then later in that same paragraph --

MR. TER MOLEN: We can move down here.

Q. -- he writes --

MR. TER MOLEN: Yeah, thank you, just over to the right there.

Q. -- "However, it is possible to use a statistical analysis to set an upper bound for any threshold that may exist."

Do you see that?

A. Yes.

Q. And then he writes "The present analysis suggests an association of blood lead level with IQ at concurrent blood lead levels as low as 5 micrograms per deciliter."

A. Yes.

Q. Do you see that?

Okay. And that's -- his view of what the science shows is that you can see a decrement to IQ where you have a blood lead level as low as 5 micrograms per deciliter, right?

MR. LANCIOTTI: Objection; form.

A. Could you repeat your question?

Q. Sure.

He writes that based on his review of the same data that you and Dr. Lanphear looked at, that that data indicates that all the way down to 5 micrograms per deciliter, it's possible to find an association between lead exposure and loss of IQ, right?

A. Right.

MR. LANCIOTTI: Object to form.

Q. Okay. And the flip of that is he did not see a scientific basis for finding harm below 5 micrograms per deciliter, correct?

MR. LANCIOTTI: Object to form.

A. I think we've talked about that already, Mark.

Q. Okay. This is where it's a matter of opinion.

MR. TER MOLEN: Okay. Why don't we introduce the next exhibit, which will be Exhibit 23. And this is the 2019 version of the paper you coauthored with Dr. Lanphear.

- - -

(Graziano Exhibit 23 marked.)

- - -

BY MR. TER MOLEN:

Q. Now, with apologies if you've explained this already, Doctor, why was it necessary to republish the paper from 2005, essentially 15 years later?

A. Because in -- along the way -- and I suspect it was Crump and coworkers -- when they looked -- so we provided all of the data to the EPA and to other groups to say, here, take a look, see what you see. And a very astute observer noticed that there was an error -- an honest error in that Harvard group -- the Boston group provided

the performance IQ, as I've said, rather than the full IQ.

So this analysis was taken on again, the reanalysis, and so this paper starts with an explanation of what the errors were and goes on to explain that, you know, essentially we reran everything we had done many years ago and that the changes in the outcome, in the scientific conclusions were essentially vanishingly small. And as I said, EPA took the second dataset and reanalyzed it and concurred with us that the errors did not change the overall results or the scientific validity or the conclusions.

Q. Okay. Well, we'll come back to this in just a second.

MR. TER MOLEN: Sam, if you don't mind putting up Page 5 from Dr. Graziano's report in this case, please.

Q. Okay. Just looking at this -- the paragraph that's sort of -- whoops, there you go -- that's highlighted here, you say "combined pool analysis," and then you say in the second line, "and subsequently modified in 2019 due to a small error in the original analysis."

Do you see that?

A. I do.

Q. Okay. And when we just read the document here -- and I'm not trying to -- did you mean to say -- instead of "small error," Doctor, did you mean to say "due to errors," plural, in the original analysis?

A. My mistake. There was one other really small error, but, yeah.

Q. Okay.

MR. TER MOLEN: Let's go back to the 2019 review. Thanks. Thanks, Sam.

Q. Okay. And then if we scroll down, there's an editor's note here that might be -- there we go -- where it says "Due to the extent of the changes throughout the text and the length of time that has passed, the complete corrected text of the article is included for the convenience of our readers. Supplemental material is also provided," et cetera.

So, basically, it sounds like that given the time that had passed, the editors asked you guys to, in essence, redo and resubmit the full paper; is that fair?

A. That's fair.

Q. Okay. And then, you know, in that -- you know, again, you indicated earlier, I think, that there's a lot of work that's been done in this area in recent years.

Is there -- did you, when you republished this paper in 2019, try to take into account all of the various studies that had looked at low-level lead exposure since the original paper was published in 2005?

A. To my recollection, we did not. This was an erratum, if you will, and we did not try to reinvent the wheel. We were trying to get the original story absolutely as accurate as we could. And if I recall, the editors -- when -- I didn't speak to them, but Lanphear did -- this was what they wanted. They didn't want to see a completely new rewrite. It would have been easier for them just to go with the former paper.

Q. Okay. That's really interesting to me, I guess, Doctor. I mean, part of the reason why is I've always thought of, you know, science, it's an incremental process. Right? There's always new studies and new information, right?

A. Sure.

MR. STERN: Object to form; move to strike the colloquy.

Q. And you agree, Doctor, that there were a number of studies with respect to lower-level lead exposure that occurred between the time that the initial paper was published in 2005 and the time the follow-up paper was published in 2019, right?

A. That's correct. But they would not have changed one iota the interpretation of the data that we were presenting.

Q. Okay. Well, let me ask you. Are you aware of any papers published between 2005 and 2019 that reached conclusions different from those reached in the 2005 initial pooled study?

A. Based on this data?

Q. Based on any data.

A. Certainly not based on this data.

Offhand, no, but I -- I don't know what you're getting at.

Q. Okay. Well, we looked today at two studies, right, that reached -- that --

A. Canadian, yeah.

Q. Yep. The Canadian study, yep. And

there was an earlier study by Taylor that also was looking at low-level blood lead levels.

And are you familiar with the paper by Lourdes, L-O-U-R-D-E-S, Schnass, S-C-H-N-A-S-S?

A. The names are certainly familiar.

Q. It was published in 2006, looking at low lead levels with respect to affecting intelligence.

A. I -- it's familiar. I cannot recall it.

Q. Okay. What about the name Min, M-I-N, a paper in 2009; are you familiar with that?

A. I don't recall.

Q. Okay. A paper by Kordas, K-O-R-D-A-S, published in 2011; are you familiar with that?

A. Again, it's familiar. It's nine years ago. I don't recall.

Q. Okay. And another paper by Brann, B-R-A-N-N, published in 2012; are you familiar with that?

A. No.

Q. Okay.

A. The power of the Lanphear publications, however, is that it -- these are seven extremely long longitudinal studies, each of which, on their

own, saw dose-response relationships between lead and IQ, and then when combined, they represent data from, as I said earlier, many cities, many countries, different cultures. And I would hold this up to any one other study that's not longitudinal and of this duration.

Q. I appreciate that.

And, Doctor, let me ask you, with respect to publishing scientific studies, you earlier were indicating some questioning as to the funding source of the folks of Crump and his group, right?

A. I wasn't pointing fingers per se. I just say we -- we have learned, whether we're studying tobacco or lead or whatever, that be wary of who is funding the work and conducting -- conducting the analysis.

Q. Well, I think -- and as part of that, I take it you're in favor of transparency on the part of the authors with respect to any potential conflicts of interests; is that right?

A. Definitely.

MR. LANCIOTTI: Object to form.

Q. And is it fair to say, Doctor, that on

your behalf, you would disclose any potential conflicts of interest if you were in the process of publishing a paper, right?

MR. LANCIOTTI: Object to form.

A. We are required to do so.

Q. Okay. And just by way of a hypothetical, then, Doctor, if you were retained by plaintiff's counsel in a lead case and while you were retained, you were publishing a paper that linked lead exposure to injury, would you make a disclosure of the fact that you were a retained plaintiff's expert?

MR. LANCIOTTI: Object to form; foundation; improper hypothetical.

A. Yes, I would be required to do that.

Q. Yeah, okay. When you say you would be required to do that, do you mean pursuant to university rules or something else?

A. University rules.

Q. Okay. And don't the publications themselves have rules requiring disclosure of potential conflicts of interest?

A. Absolutely.

Q. Okay. And you'd expect that anybody who

was publishing a paper where they had been retained by outside interests, that they would need to disclose that retention by outside interests, right?

A. Right.

Q. Okay.

A little earlier, Doctor, we talked about the category of neurological diseases later in life.

You recall that, right?

A. That's right.

Q. And I think you indicated that you're not opining today that there is a causal relationship between lead exposure and any of the neurological diseases later in life, right?

A. That's correct.

Q. With respect to the schizophrenia issue, your report cites two papers published by a gentleman -- I think a gentleman -- you can tell me if I'm wrong -- by the name of Opler, O-P-L-E-R?

A. Mark Opler was my Ph.D. student.

Q. Okay. Terrific. Good first name.

And those papers were published in 2004

and 2008, right?

A. As I recall.

Q. And are you aware that those papers were looking at groups who had been exposed to lead that resulted in their having blood lead levels greater than 15 micrograms per deciliter?

MR. LANCIOTTI: Objection; foundation.

A. As best as I can recall. It's a long time ago.

Q. Yeah.

Okay. And with respect to essential tremor, you cite two papers published by Louis in 2003 and 2011?

A. Elan Louis, yes.

Q. Okay. And the median age of the respondents in those papers was mid-60s to early 70s; is that right?

A. That is correct.

MR. LANCIOTTI: Objection; foundation.

A. Yes, as I recall.

Q. Yeah. And so it's fair to say that they would have grown up in the 1930s and 1940s?

A. That's right.

Q. And you would consider -- you would

expect that individuals growing up at that point in time would have had relatively high blood lead levels; is that right?

A. That's right. And I believe the papers actually make that point, that they likely had higher exposure to lead.

Q. Doctor, I'm having a little trouble hearing you. If you're able to speak up a little bit. Thank you.

A. Sorry.

I believe the papers actually point that out, that we, of course, given their ages, envision that they had higher exposures as young people.

Q. Okay. I think you indicated this earlier, Doctor, that the half-life of lead in blood in adults is about 30 days?

A. That's a complicated question, Mark. There were actually two half-lives. The half-life of lead in blood -- let me illustrate this. And the best illustration is some work -- take somebody who has worked in -- with lead through occupational exposure, a battery worker. And that fellow retires, and we longitudinally measure that

fellow's blood lead over time. We see that blood lead comes down initially with a half-life of roughly a month. But after about four, five, six months, the trajectory of the curve changes and it now has a second half-life, a much longer half-life. The second half-life is on the order of four years.

And what that is reflecting is the fact that at that point after his exposure had stopped, blood level comes down, but now it's -- lead in bone is an equilibrium with lead in blood. You know, we remodel bone all day long every day, and by that, I mean, you know, we have microfractures and bone cells that are repairing that. And in the process, they actually liberate some of the lead in bone.

So the initial half-life is about a month for four to six months, but then -- and there's this long, long half-life. So that's why in these cases, these papers with essential tremor, these guys have low blood leads on the order of 2 and 3. That lead in their blood is likely actually coming out of the bone reservoir that was built up a long time ago.

Q. Understand.

And that's why you'd expect the bone lead reservoir, so to speak, would have to be relatively large to result in blood lead levels like what they were seeing, right?

A. Yes. Larger than under current exposure paradigms.

Q. Yeah. Exactly. Exactly.

In 2012, you coauthored a paper on predicting later life outcomes of early life exposures; is that right?

A. Yes.

Which -- who is the first author?

MR. TER MOLEN: Well, Sam, why don't we put that one up.

A. Is it Kim Boekelheide?

Q. It is, actually. It is, yeah. I wanted you to pronounce that first, Doctor.

A. Yeah. That was actually a conference proceeding. It wasn't a study per se.

Q. Okay.

A. But it was a report back from a conference on that issue of consequences of early life exposure later in life.

MR. TER MOLEN: Okay. Why don't we put that up and we'll mark that as an exhibit.

Q. Doctor, by calling it a conference report, is that a document that would have gone through peer review?

A. Absolutely.

Q. Okay.

MR. TER MOLEN: We'll mark this as Exhibit 24.

- - -

(Graziano Exhibit 24 marked.)

- - -

A. I haven't seen this one in a long time; Mark, you're taking me through my career here.

Q. Well, it's a very accomplished career, Doctor.

And is it fair to say, Doctor, that this paper provided some examples where early life exposures to various substances could cause health effects later in life?

A. As I recall, yes.

Q. Okay. Did any of the examples discussed in the paper involve lead exposure?

A. I don't recall. I -- by your

questioning, I presume the answer is no, but I don't recall.

MR. TER MOLEN: Okay. Let's go to Page 1354. Okay. And, let's see. Thank you, Sam.

Yeah, "To date" -- on the left side column there just above the "Results" section, Doctor, if you see that.

A. Yes.

Q. Oh, thank you.

"To date" -- and this is -- "This emerging knowledge has not been incorporated into risk assessment processes or regulatory practice. Indeed, significant scientific and conceptual barriers must still be overcome," et cetera.

And making the point, I think, Doctor -- and you can put this obviously in your own words -- that it's still early days for looking at the issue of early life exposures causing health effects later in life, right?

A. That's right.

Q. Okay.

A. But more and more is learned as we go along. There are many more examples than when

this conference took place. Arsenic being one.

Q. Okay. Well, that's interesting.

And arsenic, I think you indicated for -- it may have been Bangladesh or a different location, Doctor -- is a naturally occurring element, right?

A. That's right.

Q. And it's a naturally occurring element, in fact, across the world, right?

A. That's right. But only some parts of the world does it actually enter the water -- the groundwater.

Q. Okay.

A. It has to do with the geochemical conditions of the layers of soil and sediment below the surface.

Q. Okay. But it's present in the soil, right?

A. Soil or rock.

Q. And with respect to the soil, is potential uptake or ingestion by children the same as it would be for lead?

A. No, it's not. It's not really -- it's not on surface soils, Mark. It's in layers below

the surface.

Q. Okay. Okay. Interesting.

MR. TER MOLEN: Why don't we take a break for -- gosh. Well, we can take a break and come back, or we can call it a day and start again tomorrow morning. I'd estimate I've got about another, I would say, hour and a half or so, probably at most, left.

So what would people like to do?

VIDEOGRAPHER: Should we go off the record?

THE WITNESS: Go right ahead.

VIDEOGRAPHER: The time is 4:35 p.m., and we're off the record.

(Signature not waived.)

- - -

Thereupon, the deposition was adjourned at 4:35 p.m.

- - -

STATE OF NEW YORK:
SS:
COUNTY OF _____:

I, JOSEPH GRAZIANO, PH.D., do hereby certify that I have read the foregoing transcript of my deposition given on October 29, 2020; that together with the correction page attached hereto noting changes to form or substance, if any, it is true and correct.

_____
JOSEPH GRAZIANO, PH.D.

I do hereby certify that the foregoing transcript of the deposition of JOSEPH GRAZIANO, PH.D. was submitted to the witness for reading and signing; that after he had stated to the undersigned Notary Public that he had read and examined his deposition, he signed the same in my presence on this ____ day of _____, 2020.

_____
NOTARY PUBLIC, STATE OF NEW YORK

My commission expires: _____

- - -

CERTIFICATE

I, Sara S. Clark, Registered Merit Reporter, Certified Realtime Reporter, Certified Realtime Captioner, a Notary Public, duly commissioned and qualified, do hereby certify that the within-named JOSEPH GRAZIANO, PH.D. was duly remotely sworn to testify to the truth, the whole truth, and nothing but the truth.

I DO FURTHER CERTIFY that the foregoing is a verbatim transcript of the testimony as taken stenographically by me at the time, place, and on the date hereinbefore set forth, to the best of my ability.

I DO FURTHER CERTIFY that I am neither a relative nor employee nor attorney nor counsel of any of the parties to this action, and that I am neither a relative nor employee of such attorney or counsel, and that I am not financially interested in the action.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my seal on this 13th day of November, 2020.

Sara S. Clark

Sara S. Clark, RPR/RMR/CRR/CRC
Notary Public
Registered Merit Reporter
Certified Realtime Reporter
Certified Realtime Captioner

My commission expires: March 10, 2023